Integrating adaptation into REDD+: potential impacts and social return on investment in Sogod, Southern Leyte, Philippines

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WORKING PAPER

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Abbreviations

CBA	Cost–benefit analysis
CBFMAs	Community-based Forest Management Agreements
CENRO	Community Environment and Natural Resources Office
CMA	Co-Management Agreement
CRMF	Community Resource Management Framework
CSCs	Certificates of Stewardship Contracts
DENR	Department of Environment and Natural Resources
ENSO	El Niño–Southern Oscillation
FLUPs	Forest Land-use Plans
GHGs	Greenhouse gases
LGUs	Local Government Units
MENRO	Municipal Environment and Natural Resources Office
NTFPs	Non-timber forest products
PAGASA	Philippine Atmospheric, Geophysical and Astronomical Services Administration
PENRO	Provincial Environment and Natural Resources Office
POs	People's Organizations
REDD	Reducing Emissions from Deforestation and Forest Degradation
RENRO	Regional Environment and Natural Resources Office
SFM	Sustainable forest management

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Executive summary

Field work in the Philippines was implemented with support from the Deutsche Gesellschaft für Internationale Zusammenarbeit through the Climate relevant Modernization of Forest Policy and Piloting of Reducing Emissions from Deforestation and Forest Degradation (REDD) Project in the Philippines, funded by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) under its International Climate Initiative.

REDD+ interventions can contribute to the climate change adaptation of both people and forests by conserving or enhancing biodiversity and forest ecosystem services. However, additional adaptation measures might be needed, such as the protection of agriculture and livelihoods in communities, and the improvement of fire management strategies in forests. Such measures can contribute to the sustainability of the REDD+ intervention into the future and to the preservation of carbon stocks by preventing activity displacement and induced deforestation (e.g. if an agricultural adaptation project sustains crop productivity and reduces forest clearing for agricultural expansion), and by limiting or avoiding damage to the ecosystem caused by extreme events such as El Niño (e.g. through forest fire prevention and management activities).

A bottom-up, stakeholder-focused process was conducted with selected upland barangays in the municipality of Sogod, Southern Leyte Province, Philippines, to plan for the integration of community-based adaptation interventions and assess their potential impact within the REDD+ project area. Community representatives discussed a number of different climate and nonclimate challenges and the effectiveness of current coping strategies. Adaptation interventions were then planned based on a future visioning exercise. The challenges, coping strategies and adaptation interventions were also discussed with stakeholders from different municipal and provincial organizations (e.g. local government agencies) during a 1-day participatory workshop. Projected future climate scenarios and main issues concerning the sensitivity of key resources and adaptive capacity were also discussed. A more holistic understanding was thus gained with regard to the different costs, benefits, opportunities and challenges associated with implementing the selected adaptation strategies in the target area, but also across the province more broadly.

Community groups from 7 barangays identified many common challenges. Floods, landslides, and droughts were identified as the most important climate-related challenges. However, many challenges were seen to not be related to climate, such as damaged footpaths and bridges, absence of access roads and health clinics, declining abaca (*Musa textilis* Née) production, presence of virus infestation, and wildlife loss due to excessive hunting. These nonclimate-related challenges, however, influence the capacity of community members to deal with climate hazards. Damaged footpaths and bridges, for example, make it difficult to evacuate people and assets when flooding occurs. The excessive hunting of wildlife has made this resource inaccessible in times of need when crops are destroyed during flooding or drought. On the other hand, crop failure leads to a vicious cycle, whereby even more wildlife hunting due to the lack of other alternatives (diversification), but also because of insecure land tenure.

Even though the issue of land tenure was not illustrated on the barangay maps during the exercise on defining challenges, it surfaced as an important problem during the plenary discussions when each community presented their map, which was thus added as a challenge in the voting exercise. Insecure land tenure and inadequate infrastructure were subsequently voted as the two top-priority challenges, precisely because they influence how people cope with all the other challenges.

The community representatives also identified a number of important assets and resources on their maps. Almost all barangays identified abaca, coconuts and forests as important resources, with a small number mentioning buildings such as schools and chapels, and human and social resources such as People's Organizations (POs) and microfinance institutions. Two barangays mentioned livelihood resources other than agriculture such as cut flowers

(Kahupian) and small-scale mining (Kauswagan). Wildlife was identified as an asset of intrinsic value.

Curiously enough, abaca production was prioritized as the top most-valued resource, even though bunchy top virus infestations have destroyed most of the abaca production systems in Sogod and Southern Leyte. Declining abaca production due to virus infestations was also mentioned as an important challenge by almost all of the barangay representatives. The priority voting, however, confirmed the strong cultural attachment that people have with the practice of abaca cultivation. Coconut production was ranked second, followed by rice growing, forests, root crops, vegetables, agroforestry systems, wildlife, and water and rivers, in this order.

While forests and trees are used in a number of community coping strategies and were depicted as important resources by almost all barangay representatives during the mapping exercise, they did not receive many votes in the ranking exercise. During the discussions on the voting results, community members mentioned that although these resources are important, they did not vote for them because they lack secure access to and tenure rights over them. Barangay participants expressed insecurity with regard to the tenure of agricultural fields as well.

Diversification is influenced by several factors. When severe weather events and other hazards hit the barangays, forests are used for harvesting non-timber forest products (NTFPs) such as rattan for extra income in times of disaster, and to get timber for repairing damaged houses. Wildlife (bats, wild pigs, etc.) is hunted in the forests to supplement food intake and livelihoods. Community members also mentioned participation in reforestation and agroforestry projects as a means of flood prevention and livelihood diversification. Planting vegetables, root crops, and fruit trees constitute additional strategies for diversification.

The lack of land tenure security has a direct effect on the coping strategies of the barangays and on their adaptive capacity in general. Because of this insecurity, the majority of the farmers are not incentivized to invest in agroforestry production systems (beyond the occasional government reforestation programs), which are more resilient to climate hazards in comparison to monocropping practices. In the absence of any tenure certificates, the government has jurisdiction and ownership over all trees until any claims are submitted and accepted. If trees surface on agricultural plots, farmers are afraid that they could lose their fields to the government or other claiming parties. The lack of tenure security has also led to substantial resource extraction from the forests to cope with severe weather events and other hazards, but there have been no incentives to develop and implement forest management plans.

Based on model projections, climate hazards in Sogod will become more frequent and intense in the future. With regard to temperature, the already occurring trend of increases in annual and seasonal temperature means will continue and days with maximum temperatures over 35°C will occur more frequently. The annual and seasonal precipitation means will also increase, except in the March-April-May (MAM) season, while days of heavy precipitation with rainfall above 300 mm will occur more often. The frequency and intensity of El Niño–Southern Oscillation (ENSO) events is very likely to increase as well.

Livelihoods in the upland Barangays of Sogod largely depend on the production of coconut, abaca, rice, root crops and vegetables, and on forest resources. Both agricultural production and forests are sensitive to variability in climate, extremes of climate, and longer-term climate change. Rice is very sensitive to high temperatures, especially at critical developmental stages, and to both increases and decreases in precipitation. Abaca and banana need abundant rainfall, with production decreasing at temperatures above 27°C, while cassava thrives in drought conditions and at 32°C. Sweet potato is drought resistant but cannot tolerate waterlogging, while coconut cannot tolerate extended periods of cloud cover. Tropical rain forests are prone to drought-related mortality and to fires during El Niño events.

The degree of sensitivity to external factors, however, is influenced by other destabilizing pressures and feedback loops. Forests, for example, are more sensitive to drought events and fires if they are degraded or have been logged. Crops are more sensitive to increases in temperature, precipitation, drought and pest outbreaks if they are produced as monocultures and in degraded soils, in comparison to more complex systems or agroforestry. Poor sanitation and pollution, as well as riverbank and watershed degradation, increase the severity of flooding events and the proliferation of bacteria and disease-bearing vectors during heavy precipitation. Enhanced and sustainable environmental management can decrease such sensitivity, and ultimately impacts on almost all sectors and systems.

With regard to adaptive capacity, even though natural resources are available, access to them is not secure. People use forest resources to cope with disturbances to their livelihoods, but there are no proactive resource management strategies for enhanced adaptation over time. Diversification of activities within and outside of agriculture is also low, as evidenced by the socioeconomic baseline study for piloting REDD+ activities in Southern Leyte. Furthermore, there is little presence of agricultural infrastructure in the area, such as grain storage and irrigation facilities, and no weather stations in the proximity of Sogod, all of which could help prevent crop failure, income loss and food insecurity. Future yield losses and crop failure could also lead to more exploitation of vulnerable forest resources that are openly accessible and lack management.

Forest stakeholders revealed a number of interacting challenges that all have an impact on forests and their resilience, and consequently on the accomplishment of REDD+ objectives. Insecure land tenure, for example, inhibits investments in forest and resource management, and in agricultural interventions such as agroforestry. This situation leads to a number of negative consequences. Due to the lack of agricultural investments, especially ones with adaptation benefits, climate stressors and disasters such as flood and drought induce decreased crop yields or even crop failure in the area. This in turn forces communities to clear more land in the uplands or to extract forest resources such as wild bats and NTFPs to supplement income and livelihoods (coping strategies).

The lack of forest management renders these resources, and the forests as a whole, more vulnerable to climate change (e.g. it increases the risk of fires). Without secure tenure, communities are not incentivized to engage in sustainable forest management (SFM) and to employ proactive measures such as fire risk reduction interventions and monitoring. The lack of agricultural investments (e.g. for more sustainable and resource-efficient practices) in combination with the various climate pressures also lead to the compound effect of land degradation, which can result in even more forest encroachment. Encroachment is aggravated by the in-migration of settlers from the lowlands, especially since no property rights and land-use planning regulations are in place. This is a difficult and ongoing situation for REDD+ implementation.

The communities of the upland barangays of Sogod municipality prioritized two adaptation interventions during the local-level workshops: (i) securing land tenure and (ii) restoring abaca production and related livelihoods through agroforestry. Apart from increased economic well-being, the communities identified benefits such as increased capacity to deal with environmental and socioeconomic issues through the capacitated POs (establishing POs are a necessary step in the strategy of securing land tenure), enhanced resilience of abaca and agricultural production that are under climatic and other threats, and the establishment of new livelihood opportunities for women by processing abaca fiber, etc. The costs of implementing and running these interventions were found to be associated with the different inputs for abaca agroforestry production (labor, seedlings, fertilizers and transport), and the time invested for establishing and running POs, land-use planning, conducting resource inventories and other activities associated with applying for the community-based forest management agreements (CBFMAs) and Certificates of Stewardship Contracts (CSCs) essential for securing land tenure.

Province-level stakeholders identified some additional positive spillover effects that could occur from the two interventions such as the containment of in-migration in the uplands and encroachment into forests, the increased effectiveness of awareness, education campaigns (as they will be conducted through the POs), and an increase in the attractiveness and productivity of rural employment.

Stakeholders also identified a number of opportunities associated with the two interventions. With secured land tenure, rural livelihoods will be enhanced and more sustainable, and investors could be invited to work with farmers in developing livelihoods and economic activities further. Assistance from local government agencies is available for conducting forest land-use plans (FLUPs) and this could be tapped into by the barangays, especially since there are strong partnerships between local government units (LGUs) and national government agencies such as the Department of Environment and Natural Resources (DENR) in Southern Leyte. Financial and technical support from donors could also be sought and applications for credit support programs for agricultural production and social infrastructure development (e.g. cooperatives) could also be made. With regard to abaca agroforestry, semiprocessing and other value chain activities such as weaving could be supported. The implementation of this intervention is also an opportunity to make use of the extension services offered by the Fiber Industry Development Authority (FIDA) and other agencies.

However, several important challenges, threats and potential unintended consequences need to be considered, as mentioned at the province-level workshop. Maintaining the commitment of LGUs to implement the FLUP and the availability of technical staff to facilitate the CBFM and tenure agreement processes are just some of the challenges associated with securing land tenure. Others relate to the long approval process of CBFMAs (even though on paper the process seems short) and the longevity of government programs that are linked to it. Clarifying the activities, determining the cost of the process, and delineating the land areas correctly are challenges that will most likely be encountered at the start of the intervention. With abaca agroforestry, the main challenges reported are the sustainable adoption of adequate intercropping practices and the timely coordination with FIDA. Identifying the underlying causes of abaca virus infestations in order to minimize future risks is another issue.

The two strategies could result in unintended impacts, which will need to be detected and dealt with as early as possible. These mostly relate to broader impacts at the provincial level. For example, speculators might take advantage of the newly established tenure agreements, which could lead to farmers selling off their tenured lots. The benefits of containing migration and encroachment into forested zones might not come to fruition and the strategy may even produce detrimental effects. As secure land tenure will lead to enhanced livelihoods and economic development, this could attract new settlers from the lowlands who will need to find land for housing and agriculture. This same unintended consequence could materialize as a result of the abaca agroforestry intervention as well.

Other concerns that were flagged in relation to the abaca agroforestry intervention include "loan sharks" taking advantage of farmers who are willing to implement the intervention on their plots, continued exploitation by middlemen along the value chain if cooperatives are not established, and conflicts with government officials who seek to enforce forest protection policies if agroforestry is practiced in the forest margins or within forested lands. Adequate monitoring, capacity building and sufficient extension and financial support services could prevent such unintended consequences from occurring.

The intervention of securing land tenure does not present any risk of failure under the different plausible climate change scenarios, but there are certain climate and biophysical thresholds that need to be monitored for the abaca agroforestry system to thrive.

With regard to increases in temperature, abaca grown under agroforestry systems is more resilient than that in monoculture plantations due to the microclimate regulation and shading provided by the trees (shaded abaca results in 165% more fiber yield in comparison to monocultures). However, drought events brought by El Niño could decrease the physiological activity of abaca, especially if such events occur right after planting and before the trees have started to form their canopies. Farmers should thus have the readiness to proceed with irrigation during this initial establishment phase. In general, however, established agroforestry systems are much more resilient to both drought and increases in precipitation than monocultures.

The productivity of various fruit tree species can, however, be impacted by extreme temperature and precipitation values, and measures such as irrigation and drainage canals might need to be implemented. Durian, for example, grows best with a mean annual temperature of 22°C and a mean annual rainfall of 1,500–2,000 mm. Soils should be well drained to limit losses from root rot. Rambutan, on the other hand, has a higher tolerance and can thrive with annual mean temperatures as high as 35°C. But this species too does not favor waterlogging. Lanzones need plenty of moisture and will not tolerate long dry seasons. While this type of fruit tree tolerates long rainy seasons (e.g. in Java, the tree has been shown to grow well in areas with 6–12 wet months), it does not tolerate waterlogging. Nevertheless, even if fruit yield is impacted under increased temperatures or changes in precipitation, these trees will continue to provide valuable services to abaca (shade, cooling, water pumping, etc.). Abaca agroforestry systems have also been shown to recover more quickly from disturbances than do monocultures.

In relation to REDD+ objectives, stakeholders envision that the two adaptation strategies prioritized by the barangays — securing land tenure and abaca agroforestry — will have a mutually enhancing and positive impact, but only if they meet their objectives and if the challenges and potential unintended consequences outlined above are managed appropriately.

With secure land tenure and capacitated POs, communities will be more incentivized to invest in resource management and agricultural practices such as abaca agroforestry. Abaca agroforestry will in turn lead to enhanced livelihoods, diversified income opportunities and restoration of degraded land, all of which will contribute to reducing deforestation and to managing resources sustainably. The latter are a compound effect of secure land tenure, land-use planning, and the implementation of agroforestry. As a result of tenure and land-use planning, the negative effects of in-migration (e.g. encroachment into forested lands) will be constrained. Sustainable resource management of both forest and agricultural resources will lead to an overall increased social and environmental resilience. The presence of capacitated POs will further contribute to enhancing people's adaptive capacity to anticipate and deal with hazards effectively. This situation of "adapting" will facilitate the successful implementation of REDD+ and the triple objectives of adaptation, mitigation and development.

In addition to the direct impacts of adaptation projects, positive indirect impacts on REDD+ can occur when an adaptation project prevents activity displacement and induced deforestation (e.g. if an agricultural adaptation intervention sustains crop productivity and livelihoods and reduces forest clearing for agricultural expansion). The evidence on these linkages from the climate change literature is scarce, but studies have been conducted on the relationships between practices such as agroforestry and CBFM (which are relevant for adaptation) and reduced deforestation (relevant for REDD+) outside of the climate change debate. Agroforestry systems can also have benefits for biodiversity and forest adaptation as they both reduce human pressure on forests and serve as biological corridors. It has been demonstrated that agroforestry systems play host to significantly more species in comparison to monoculture systems.

Further synergistic benefits could be pursued from a joint implementation of REDD+ and adaptation strategies in order to maximize the overall positive impact. For example, REDD+ networks and finance could be used to deliver timely climate information and knowledge that is of relevance, not only for the adaptation of agrarian communities, but also for the adaptation of the forests. Such information could be integrated into an adaptive governance and management model, where the results of different interventions are constantly monitored, evaluated and readjusted according to changing circumstances and needs (e.g. changing drivers of deforestation and degradation, changing climate pressures). Adaptive management should be the foundation of any intervention under uncertainty.

1. Objectives and activities

1.1 Main goal and objectives

The study "**Integrating Adaptation in REDD+ Projects: Potential Impacts and Social Return on Investment** (SROI)" was conducted by the Center for International Forestry Research (CIFOR) in two pilot sites in Indonesia and the Philippines. It was funded by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) with a grant from the German Federal Ministry for Economic Cooperation and Development (BMZ). Field work in the Philippines was conducted in September 2012 with support by the GIZ Philippines Team of the Forest Policy and Piloting of Reducing Emissions from Deforestation and Forest Degradation (REDD) Project in the Philippines, funded by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) under its International Climate Initiative.

The main goal of the study was to analyze the potential impacts of integrating different community-based adaptation interventions in REDD+ pilot projects by forecasting their social return on investment (SROI). Forest-dependent communities and local and subnational decision-making and practitioner groups that influence or are impacted by REDD+ pilot activities were the main target groups.

More specifically, the following objectives were pursued:

1. To assess vulnerability to climate variability and change through desktop analysis and participatory methods and define adaptation interventions with stakeholders at different levels;
2. To analyze the potential social, economic and environmental outcomes of selected adaptation interventions from the perspectives of the stakeholders concerned; and
3. To forecast the impact and overall value that can be created if the different interventions meet their intended outcomes, especially in comparison to inaction or no adaptation interventions.

The study also aimed to evaluate and refine the SROI framework for adaptation planning and produce a practitioners' guidebook for the replication of activities at other sites.

1.2 The SROI framework

SROI is a framework inspired by the principles of economic cost–benefit analysis, impact assessment and social accounting that seeks to understand and manage the value of the social, economic and environmental outcomes created by an activity or an organization. SROI was pioneered by The Roberts Enterprise Development Fund (REDF) in early 2000 and has been evolving ever since. This study is based on the latest version of the framework, A Guide to Social Return on Investment (Nicholls et al. 2012), which is promoted by the UK government for the evaluation of nonprofit and social enterprise activities and organizations.

The SROI process involves reviewing the inputs, outputs, outcomes and impact of an intervention or organization by producing an impact map. Social, environmental and economic outcomes are determined by the stakeholders who are experiencing them. A monetary value is put on the outcomes wherever possible, using prevailing market prices for traded goods and financial proxies for intangible and nonmarketable outcomes (e.g. more free time for women).

Stakeholder participation and analysis is at the center of the approach where social and other impacts are conceptualized by the stakeholders themselves. In contrast to traditional cost–benefit analysis (CBA), SROI analyses change in a way that is relevant to the people or organizations that experience or contribute to them.

The theoretical basis of SROI is theory of change. Theory of change (ToC) takes into account the chain of events and outcomes connected to a specific intervention. It identifies where and how value is being created, by whom, and who benefits from it and how. It examines how outputs are, or will be, used to create value, what are the initial changes or benefits, and what are the potential longer-term results situated in time and space. ToCs clearly articulate the assumptions behind early, intermediate and long-term outcomes and their interconnections, and the conditions that need to be present in order for them to materialize.

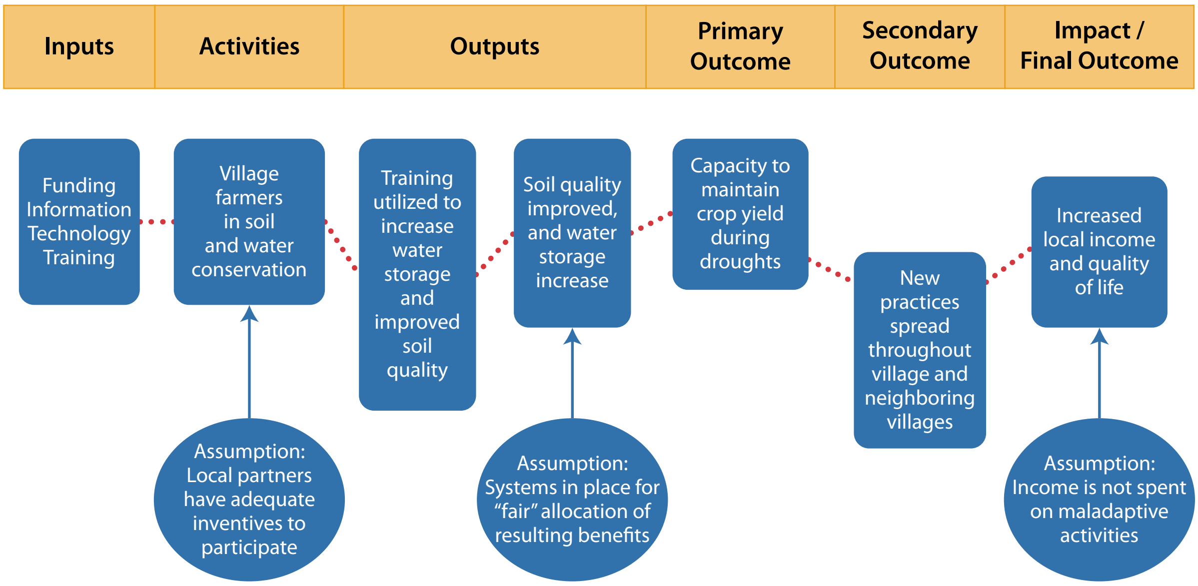

Figure 1. Schematic example of theory of change after Spearman and McGray (2012), World Resources Institute.

Evaluative SROI analyses are conducted retrospectively and are based on actual outcomes that have already taken place. Forecast analyses predict how much impact and social value will be created if given activities meet their intended outcomes. Forecast SROIs are especially useful in the planning stages of an activity. They can help show how investment can maximize impact, the barriers that need to be overcome for this, and are also useful for identifying what should be monitored and evaluated once the project or program is up and running.

SROI has been applied extensively for forecasting and evaluating social value in the nonprofit sector in programs such as skills training for disadvantaged groups, housing and community development services, mental health rehabilitation, and community gardening, mostly in Western countries (SROI Network 2012). It has only recently been applied in adaptation through its forecasting form by Sova et al. (2012) from the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).

The SROI framework can be useful for the adaptation planning process and for forecasting the impact of adaptation interventions. With SROI, the social and other impacts are conceptualized and valued by the stakeholders, reflecting their actual needs, priorities, and also potential roles for the implementation of the adaptation strategy (Chaudhury 2012).

Sova et al. (2012) enhances the SROI framework and its applicability for adaptation planning and costing by adding core principles and practical components from community-based adaptation, participatory rural appraisal, and strength-based approaches to development. The enhanced forecasting framework takes an even greater bottom-up approach by supporting the communities in designing their own adaptation interventions based on their values and capacities through participatory workshops.

2. Study site and context — the Philippines

2.1 Study site

The municipality of Sogod in the Philippines (Southern Leyte Province) was selected as the study site after consultation with the REDD+ team.

Sogod is one of 5 target municipalities in Southern Leyte Province for the project "Climate-relevant Modernization of the National Forest Policy and Piloting of REDD Measures in the Philippines" implemented by GIZ together with DENR and LGUs with funding from the International Climate Initiative of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). The project aims to improve forest policies, to create specific incentives for forest protection and rehabilitation, to reduce greenhouse gas (GHG) emissions, to encourage biodiversity conservation, and to enhance the capacities of partner institutions.

The project supports the Philippine National REDD-Plus Strategy (PNRPS) by contributing to the preparations for full REDD implementation through activities such as analysis and revision of forest policies, conducting forest resource assessments, and developing frameworks, incentive structures, and monitoring systems for the conservation and sustainable management of forests together with local stakeholders and communities. Examples of incentives include the clarification of land tenure, provision of financial support for forest rehabilitation and reforestation, and the establishment of agroforestry and village development systems. The project fully supports the preparation and finalization of the forest land-use plans of the five target municipalities, one of which was already finalized in 2011.

Since the total pilot area of the project is vast, covering 5 municipalities and 71 barangays with an area of more than 40,000 ha, the boundary of the community consultations of this study was narrowed down to 1 municipality — the municipality of Sogod — and more specifically to the upland areas. The community workshop was conducted with representatives from 7 upland barangays, the lowest administrative level in the Philippines one.

2.2 The context in Southern Leyte and Sogod[1]

Southern Leyte is one of the 6 provinces of Eastern Visayas Region with a total land area of 1,734.8 km^2 and is characterized by relatively flat lands along coastal areas that become rugged and mountainous towards the interior. The province rests within the Philippine Fault System, with major fault lines running through the municipalities of Sogod, Libagon, St. Bernard and San Juan to Panaon, rendering them vulnerable to landslides and flooding.

The province is a major player in the Philippine economy, as it is serviced by important inter-island transportation systems and is the major producer of abaca fiber in the country. It is divided administratively into 19 LGUs, which encompass 18 municipalities and the city of Maasin (the capital of governance, commerce, and finance in Southern Leyte).

Southern Leyte has a population of 390,847 with a 1.13% growth rate as of 2007 and a population density of 168.4 people per square kilometer. The three biggest portions of its population are distributed in Maasin City (79,737), and the municipalities of Sogod (39,864) and Bontoc (28,535). Even though the province has the second-smallest population share in the region, its population growth rate is comparatively high, which is attributed to in-migration and the increase in birth rate over mortality rate. This increasing trend is evident in the 5 LGU pilot sites of Bontoc, Maasin City, Silago, Sogod and Tomas Oppus.

As of 2009, the average annual income of families in Southern Leyte was estimated at PHP 141,641 (a 21.6% increase in comparison to 2006), with an annual family expenditure of PHP 117,003 (a 14% increase). The province does not have any great landholdings and its total land

1 Information from the report "Socio-economic Baseline for the REDD+ Project Sites in Southern Leyte, Philippines," the National Statistical Coordination Board, and the 2009 City and Municipal-level Small Area Poverty Estimates.

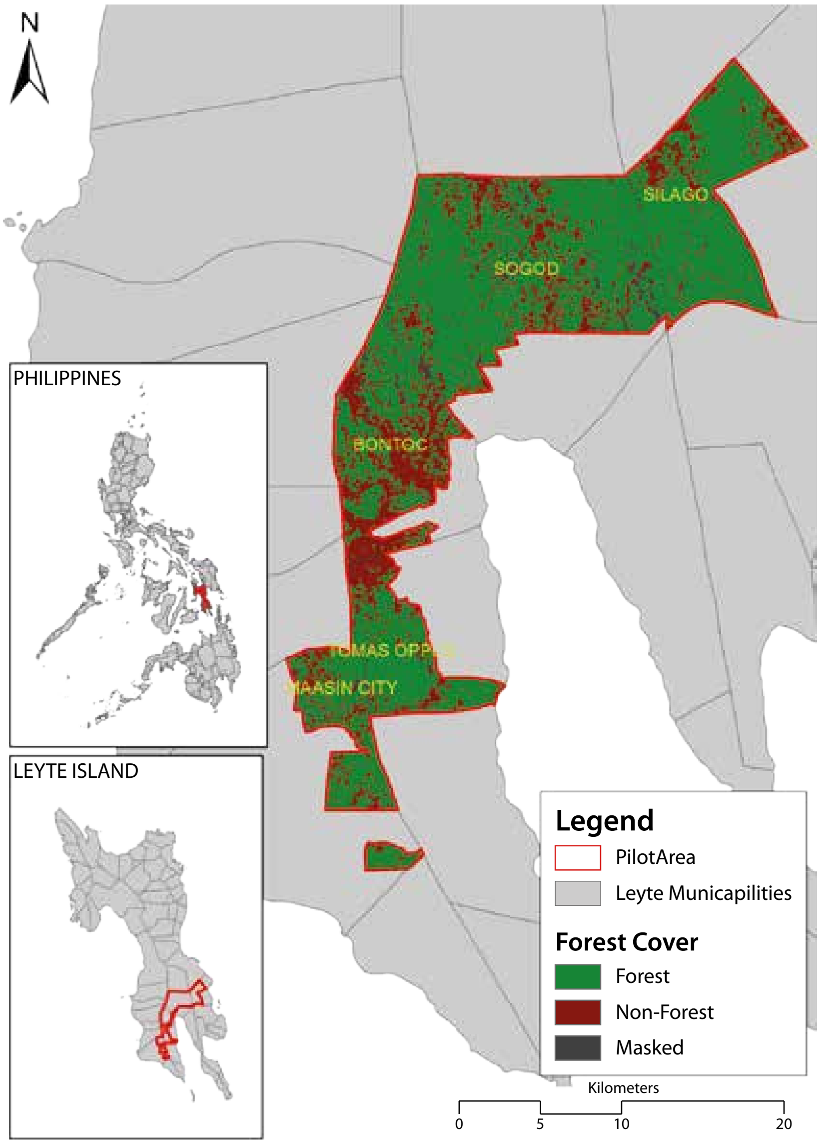

Figure 2. Map of the project area covering the 5 municipalities of Silago, Sogod, Bontoc, Tomas Oppus, and Maasin.

area can be classified into forest land (47,519 ha or 27.4% of the total area) and alienable and disposable land used for production and other purposes (125,961 ha or 72.6%). Production is devoted to the cultivation of annual crops, irrigated rice, perennial trees and vine crops, and aquaculture (fishponds). The major crops are coconut and abaca.

Sogod is the third-largest LGU in the province with a total land area of 19,270 ha and a population of 41,411 spread among 45 barangays (as of 2010). According to the Philippines Income Classification System, Sogod is a class II municipality, meaning that the total average annual income during the last three calendar years was between PHP 45 and 55 million. However, the poverty incidence in the municipality is relatively high, amounting to 36.8%.

Sogod is predominantly mountainous with flat plains in the southern part and numerous rivers and creeks, many of which are considered hazardous. A total of 15,112 ha is alienable and disposable land and 4158 ha is forest land. Production concentrates on annual crops (7094 ha), perennial tree and vine crops (6853 ha), irrigated riceland (709 ha), rainfed riceland (10 ha), production forests (native, 874 ha), and community-managed forests (CBFM, 2152 ha). The main crops are copra, tobacco, abaca and root crops. Small-scale manufacturing is also present, with the main products being coconut shell charcoal, abaca products and handicrafts, ceramics, coconut oil, furniture, hollow blocks, and gravel and sand (mining and quarrying businesses).

3. Methods

3.1 Community workshop

This study adopted the main community-based adaptation planning activities as suggested by Sova et al. (2012) and CARE International.[2] A 2-day participatory workshop (03–04 September 2012) was organized in the town proper of Sogod in Sogod Municipality and was attended by 30 representatives from 7 barangays (Benit, Hipantag, Kahupian, Kauswagan, Santa Maria, San Vicente and San Juan), including the barangay chiefs. The main objectives of the workshop were to determine the underlying causes of vulnerability, to understand how climate challenges fit within the broader challenges faced by the community, and to incorporate community values and priorities in the selection, planning, and evaluation of adaptation interventions. A special focus was given to forest and tree resources and their role in coping and adapting strategies.

Figure 3. Mapping and break-out group discussion in Sogod, Southern Leyte.
Photo by Gordon Bernard Ignacio/GIZ.

The following activities were included:

1. Identifying community values and assets through break-out group discussions and community mapping;
2. Identifying environmental and other challenges and prioritizing the most important challenges through group discussions and voting;
3. Identifying historical responses and coping strategies associated with the challenges and discussing their effectiveness;
4. Elaborating visions for the future through community mapping;
5. Designing and selecting priority adaptation interventions by discussing common future aspirations of community members and conducting priority voting;
6. Planning the implementation of priority interventions through backcasting; and
7. Identifying the costs and benefits and the overall impact of priority interventions from the perspective of the community members, also in relation to forest management and REDD+, through break-out group discussions.

Community members identified a number of hazards and challenges through the barangay mapping exercise. The mapping exercise was useful for visualizing the location of these challenges and the interrelationships between them, and also for discussing the available resources and coping mechanisms.

Community-based adaptation principles and tools were integrated into the activities of the community workshop to plan and prioritize adaptation interventions in the context of multiple stressors. Barangay representatives were asked to envision a

Figure 4. Barangay map of San Vicente, depicting important resources, challenges and hazards, and coping mechanisms.
Photo by Gordon Bernard Ignacio/GIZ.

2 Useful resources such as the CARE International Community-based Adaptation Toolkit (http://www.careclimatechange.org/tk/cba/en/) can be found in the annex of the upcoming guidebook.

future where stressors and challenges are addressed in an integrated manner, with the mobilization of existing assets and resources wherever possible (natural, financial, human, physical and social). The desired future characteristics were then used to prioritize and plan no-regret adaptation interventions based on the needs, aspirations and capabilities of the barangay residents.

Future visioning was conducted through barangay mapping. Barangay presenters were asked to show their future village maps of 2030, explaining what has changed in relation to the previous map (current situation). The common components that surfaced from the different barangay maps of the future were clustered into groups and rephrased as statements (aspirations) for the planning of strategies. Participants were also asked to place their priority votes on these different aspiration clusters.

Planning was done through backcasting. Backcasting is a process of systematically going backwards from a desired future situation until the present is reached by continuously asking the question: "What do we need to do to achieve this?" (Sova et al. 2012). In Sogod, backcasting and planning were conducted with the use of a long sheet of paper and Post-It notes. The desired characteristics of the future were illustrated at the right side of the sheet, while the current situation and the available assets and resources were placed on the left side. Backcasting can be used to establish a plan for using the available community resources to implement a prioritized intervention, keeping in mind the aspirations that people have for the future. It can reduce the scope of the intervention to a manageable starting point, and it also helps to identify barriers and costs to implementation, incentives for participation and tangible and intangible values associated with each input and benefit. During the backcasting exercise and intervention planning, barangay members were asked to consider all the positive (intended) and negative (unintended) impacts that might occur during the different implementation phases.

3.2 Province-level workshop

A 1-day workshop was organized for 31 province-level stakeholders in Maasin City, the capital of Southern Leyte (13 September 2012). The following agencies participated in the workshop, in addition to GIZ staff members from the region:

- Forest Management, Department of Environment and Natural Resources (DENR)
- Forest Management, Community Environment and Natural Resources Office (CENRO), DENR, Maasin City
- Provincial Agricultural Reform Office (PARO), Department of Agrarian Reform (DAR)
- Community-based Forest Management (CBFM), coordinated by DENR-CENRO, San Juan
- Forest Management Bureau, DENR
- CBFM/REDD Coordination, Local Government Unit (LGU), Maasin City
- Municipality Environment and Natural Resources Office (MENRO), LGU Silago
- Secretariat LGU Sogod
- MENRO LGU Tomas Oppus
- Visayas State University
- Provincial Environment and Natural Resources Management Office (PENRMO)
- Provincial Agricultural Services Office (PAGSO)
- Provincial Planning and Development Office (PPDO)

Two representatives from the barangays Benit and Kauswagan who had attended the community workshop, also participated in the provincial workshop to communicate the outcomes from the community work.

The main objectives of province-level consultations were to communicate the results from the community workshops and from climate and vulnerability analysis to elicit perceptions on the critical challenges faced in the region as related to adaptation and forest management/REDD and to discuss not only the costs and benefits, but also the challenges, opportunities and risks associated with the implementation of the priority adaptation interventions identified at the community level.

The following activities were included, in this order:

- presentation of community perceptions related to important resources, challenges and coping strategies in the municipality of Sogod by community representatives and facilitators;
- presentation of the preliminary results from the climate and vulnerability analysis and discussion;
- group work on identifying the most important challenges and associated solutions from the perspective of the provincial stakeholders;
- presentation of the two priority interventions by community representatives and facilitators;
- group discussion on the costs, benefits, challenges, threats, and opportunities

related to the implementation of the priority interventions; and
- presentation of the progress of REDD+ activities and discussion by the GIZ-Philippines.

3.3 Climate change and vulnerability analysis

3.3.1 Framework

The climate and vulnerability analysis was conducted through the vulnerability framework (where vulnerability is considered to be a function of exposure, sensitivity and adaptive capacity).

In Figure 5, the exposure component encompasses current climate variability and projected future climate change, including extreme events. It essentially describes the nature and degree of the climate stress upon a system. Sensitivity describes how the system reacts to or is affected by the climate stressors, while adaptive capacity focuses on the ability of the system to accommodate these stressors and their consequences for minimizing harm or maximizing any opportunities. Adaptive capacity can be influenced by many factors such as wealth, ecosystem integrity, infrastructure, and availability of and access to technology, education and information, (Smit et al. 2001).

In summary, the degree of negative climate hazard impacts in a system depends on the system's

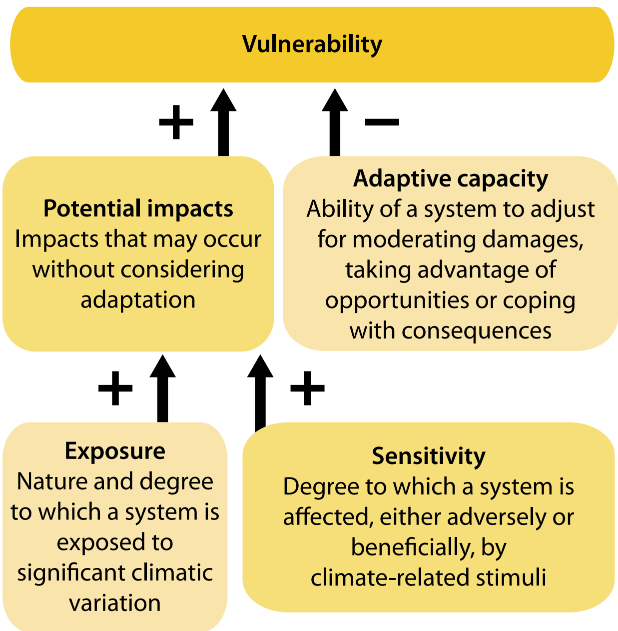

Figure 5. Vulnerability as a function of exposure, sensitivity and adaptive capacity (Locatelli 2011).

vulnerability. Negative impacts do not occur solely because there is an exposure to a climate hazard, but because there is significant sensitivity to this hazard and limitations in the capacity to adapt to it.

Adaptation actions are usually planned to address one or several elements of this framework. They may aim to decrease underlying causes of vulnerability (e.g. ensuring access to resources and healthcare) or to modify the exposure to, and effects of, a specific climate hazard (e.g. building barriers to protect settlements against coastal storms). They can be either incremental or transformational. Incremental adaptations refer to extensions of actions and behaviors that already reduce vulnerability, whereas transformational actions are those that are adopted at a much larger scale or intensity and/or are truly new to a particular region or system (Kates et al. 2012).

However, climate hazards and their impacts rarely occur in isolation. Systems are usually under the pressure of various stressors that frequently interact, resulting in compound impacts and feedback loops of vulnerability. Socioecological systems in Sogod exist in a multistressor environment, where many of the stressors influence sensitivity and the capacity to adapt to other challenges, especially the climate-related ones. As discussed below, degradation and deforestation, for example, render forests more sensitive to drought conditions and limit their capacity to recover from forest fires.

Each element of vulnerability focuses on the issues of concern to the decision makers and practitioners of upland communities in Sogod and Southern Leyte. The climate and vulnerability analysis aims to complement the stakeholder consultations and perceptions by providing additional input from the literature on possible scenarios and critical vulnerability thresholds. It also aims to provide input for adaptation planning and to serve as the basis for an initial assessment of the robustness of the prioritized adaptation interventions under any plausible climate scenarios.

3.3.2 Exposure

Exposure is related to both current and projected future climate variability, trends and extremes. It refers to the nature and degree of the climate stress upon a system at various levels and scales. Different types of exposure to climate hazards can occur along different temporal scales. Exposure can relate to the frequency and intensity of abnormal or extreme

Figure 6. Reference point for climate data analysis.
Source: Google maps.

events (e.g. stronger and more frequent storms), the frequency and intensity of climate variability (e.g. alterations in wet and dry months or years, fluctuations in daily minimum and maximum temperatures), the shifting of seasonality in time and space (e.g. long rainy periods in the dry season), or long-term incremental trends and slow-onset changes (e.g. an increase of 1°C annual mean temperature by 2050).

As there are no meteorological observation stations in near proximity to Sogod (the closest stations are in Tacloban and Maasin), we used interpolated datasets, i.e. datasets that use measurements from numerous weather stations around the world and that apply tested algorithms to infer climatic data for any point in a global grid. We used the WorldClim[3] dataset for the mean climate, and the data from the climate databases of Tyndall Centre's Climate Research Unit (CRU)[4] for past annual data and climate trends. A point in the middle of Sogod Municipality was used as the reference point for retrieving all climate data.

WorldClim constitutes a set of global climate layers (climate grids) with a spatial resolution of about 1 km. Interpolations of observed data are representative of the years 1950–2000. The CRU data sets include month-by-month variations in climate at a resolution of 0.5 arc-degree (around 50 km), based on climate archives from more than 4000 weather stations around the globe. For both datasets, we considered only two climate variables: precipitation and temperature.

Future climate trends were retrieved from the TYN SC 2.0 data set of the Tyndall Centre for Climate Change Research. The TYN SC 2.0 data set comprises monthly grids of modeled climate, including cloud cover, diurnal temperature range DTR, precipitation, temperature, vapor pressure for the period 2001–2100, and covering the global land surface at 0.5 degree resolution (50 km^2). We used the outputs of 4 general circulation models (GCMs)[5] combined with 4 emission scenarios of the IPCC.[6] The emission scenarios are A1FI (integrated world characterized by rapid economic growth and high use of fossil fuels), A2 (more divided world, regionally-oriented economic development), B1 (world more integrated and more ecologically friendly), and B2 (world more divided and more ecologically friendly). The four general circulation models are as follows: CGCM2, CSIRO mk 2 (CSIRO2), DOE PCM (PCM), HadCM3 (HAD3). Data were retrieved for the years 2020, 2050, and 2080, using as a reference point a location in the center of Sogod (as depicted in Figure 6).

Relevant secondary data from other climate analyses (national reports and vulnerability assessments) are also included in the exposure section.

3.3.3 Sensitivity and adaptive capacity

The degree of sensitivity indicates how responsive a system is to certain climate variables or extremes. More sensitive systems will show larger changes in composition or structure in response to disturbance events.

The sensitivity of key resources and sectors to climate hazards (e.g. agricultural production systems, health, and settlements) was analyzed by conducting a

3 http://www.worldclim.org/.

4 http://www.cru.uea.ac.uk/home.

5 GCMs are mathematical representations of the climate system, simulating the physical and dynamical processes that determine the global climate. These computer models divide Earth into horizontal and vertical grid cells, where each cell represents a specific climatic state for a specific time based on a set of equations.

6 http://www.ipcc.ch/ipccreports/sres/emission/index.php?idp=0.

literature review. Key resources and sectors were identified from the community consultations and desktop analysis. The analysis of adaptive capacity was also based on stakeholder perceptions from both the community and district/provincial levels and information from the literature.

Adaptive capacity is generally associated with the capability of a socioecological system to be robust to disturbance and to adapt to actual or anticipated changes whether exogenous or endogenous (Plummer and Armitage 2010). With regard to social systems, adaptive capacity is determined by the suite of resources that are available and the social processes and structures through which they are employed and mediated. One of the most important factors shaping the adaptive capacity of individuals, households and communities is their access to and control over natural, human, social, physical and financial resources. Examples of resources affecting adaptive capacity include irrigation infrastructure and weather stations (physical), community savings groups and farmer organizations (social), reliable freshwater sources and productive land (natural), microinsurance and diversified income sources (financial) and knowledge, skills and education (human).

4. Stakeholder views

4.1 Community level: Perceptions about challenges, resources and coping strategies

4.1.1 Challenges

The groups from the 7 barangays identified many common challenges.[7] Floods, landslides, and droughts surfaced as the most important climate-related challenges. However, many challenges were identified as being nonclimate ones, such as damaged footpaths and bridges, absence of access roads and health clinics, declining abaca production and virus infestation, and wildlife loss due to excessive hunting. These nonclimate challenges, however, influence the capacity of community members to deal with climate hazards. Damaged footpaths and bridges, for example, make it difficult to evacuate people and assets when flooding occurs. The excessive hunting of wildlife has made this resource inaccessible in times of need, when crops are destroyed by flooding or drought. On the other hand, crop failure leads to a vicious cycle of even more wildlife hunting because of the lack of other alternatives (diversification) and insecure land tenure.

Even though the issue of land tenure was not illustrated on the barangay maps, it surfaced as an important problem during the plenary discussions when each community presented their maps (land tenure was thus added as a challenge in the voting exercise). Insecure land tenure and inadequate infrastructure were voted as the two top-priority challenges (Table 1)[8] precisely because they influence how people cope with all other challenges.

4.1.2 Assets and resources

When asked to illustrate the different resources (environmental, social, human, financial, etc.) and assets of value in their communities, barangay members identified a number of resources on their maps. Almost all barangays identified abaca, coconut and forests as important resources, with a small number mentioning buildings such as school and chapels, and human and social resources such as People's Organizations (POs) and microfinance institutions. Two barangays also mentioned livelihood resources other than food-based agriculture, such as the growing of cut flowers (Kahupian) and small-scale mining (Kauswagan). Wildlife was identified as an asset of intrinsic value.

Table 1. Priority voting on hazards and challenges.

Hazard or challenge	Total no. of votes
Insecure land tenure	24
Inadequate transportation infrastructure (lack of roads, and damaged footpaths and bridges)	13
Floods	11
Landslides	9
Declining price of copra	7
More dry months	4
Decline in abaca production	2
Excessive wildlife hunting	0
Forest degradation due to slash-and-burn farming	0

A voting activity was conducted for common clusters of resources and assets as well, with abaca production gaining the majority of the votes (Table 2).

Curiously enough, abaca production was prioritized as the top most-valued resource, even though bunchy top virus infestations have destroyed most of the abaca production systems in Sogod and Southern Leyte. Declining abaca production because of virus infestations was also mentioned as an important challenge by almost all of the barangay members. The priority voting, however, confirmed the strong cultural attachment that people have with the practice of abaca cultivation.

4.1.3 Coping strategies

Many of the resources mentioned are used extensively in the coping strategies of the communities when climate hazards hit the barangays (Table 3). Forests are used for harvesting non-timber forest products (NTFPs) such as rattan for extra income in times of disaster and to source timber for repairing damaged houses. Wildlife (bats, wild pigs, etc.) is hunted from

7 A list of challenges, resources, and coping strategies per barangay can be found in the annex.

8 Each community member was given 3 votes to distribute among any one challenge he or she prioritized as most important. Participants were allowed to place all 3 votes on one challenge, but only if they wished to do so.

Table 2. Priority voting on assets and resources.

Assets and resources	Total no. of votes
Abaca production	35
Coconut production	18
Rice fields	5
Forest	5
Root crops	4
Vegetables	4
Agroforests (fruit trees)	3
Wildlife	1
Water and rivers	1

Figure 7. Abaca farmers in Sogod processing their harvest.
Photo by Ronald Tagra.

the forests to supplement food intake and livelihoods. Community members also mentioned participation in reforestation and agroforestry projects as a means of flood prevention and livelihood diversification. Planting vegetables, root crops, and fruit trees constitute additional strategies for diversification.

Forests and trees are used in a number of community coping strategies and were also depicted as important resources by almost all barangay members during the mapping exercise. However, they were not ranked highly during the priority voting (Table 2). During the discussions on the voting results, community members mentioned that although these resources are important, they did not vote for them because they lack secure access and tenure rights over them. Barangay participants expressed insecurity with regard to the tenure of agricultural fields as well.

Table 3. Coping mechanisms and strategies.

Strategy	Main goals
Participate in reforestation and agroforestry projects	Prevent floods and provide alternative livelihoods
Ask for assistance from the LGUs for building bridges and other activities	Reduce disaster risk
Initiate barangay repairs (e.g. relocation of footpaths, small road repairs, etc.)	Disaster risk reduction
Harvest and sell NTFPs (rattan)	Supplement livelihoods
Plant vegetables, root crops, and fruit trees	Diversify
Seek external financial aid	Manage disasters (recoup post disaster)
Seek external labor	Supplement livelihoods
Hunt wildlife (e.g. wild pigs)	Supplement food intake and livelihoods

The lack of land tenure security has a direct effect on the coping strategies of the barangay residents and on their adaptive capacity in general. Because of this insecurity, the majority of the farmers are not incentivized to invest in agroforestry production systems, which are more resilient to climate hazards in comparison to monocropping. In the absence of any tenure certificates, the government has jurisdiction and ownership over all trees until any claims are submitted and accepted. If trees sprout on agricultural plots, for example, farmers are afraid that they will lose their fields to the government or other claiming parties. The lack of tenure security has also led to substantial resource extraction from the forests to cope with weather events and other hazards, but without any incentives to develop and implement forest management plans.

4.2 Province-level consultations: Important challenges, solutions, and forest management

When the participants were divided into 2 break-out groups to further discuss challenges and solutions at the provincial level, both groups identified issues from themes such as tenure and land-use planning, migration, resource extraction and land conversion, and the occurrence of disasters. A summary of all challenges and solutions is presented in Table 4.

Figure 8. Break-out group discussion, Maasin City.
Photo by Gordon Bernard Ignacio/GIZ.

4.2.1 Land tenure, land-use planning, and migration

Both groups emphasized the issue of land tenure by pointing out a number of interconnected challenges such as the absence of land-use boundary delineation, encroachment of settlers from the lowlands into the forested uplands, and land clearing for agricultural expansion because of in-migration. Since there are not many certificates of land ownership issued by the Department for Agrarian Reform (DAR), conflicting claims over land are a frequent occurrence in the region. Because of the absence of land-use plans based on explicit spatial parameters, and the subsequent fuzzy boundaries between agricultural production and forests, resources are mismanaged and the risk of conflicts is high. The lack of ownership certificates and land-use plans also allow new settlers to convert forests and timberlands for agriculture, including in the fragile mangrove lowlands.

People migrate from the lowlands to the uplands for subsistence. They are usually resource constrained, poorly educated and opt for farming by clearing new land. The LGUs are trying to organize these communities and work with them as partners to slow deforestation. However, POs need to be established first. Once POs are established and registered, DENR could issue community-based forest management agreements (CBFMAs), conduct planning and start the implementation of activities (capacity building, tree planting, conservation, resource inventories, etc.). Corresponding resource-use permits could then be issued for the harvesting of non-timber forest products (NTFPs) or planted trees. Other solutions that the province-level stakeholders would like to pursue include proper forest resource surveys and demarcation, riparian zone establishment by DENR, and ridge-to-reef planning with a convergence of programs.

4.2.2 Deforestation, land-use conversion and resource extraction

In close relation to the issue of land-use and tenure, the challenges of resource extraction and land-use conversion were extensively discussed. Apart from land-use conversion for agriculture, new settlements and other purposes, illegal timber poaching is still an issue in Southern Leyte. Illegal timber poaching occurs mainly due to limited livelihood opportunities and is practiced for the production of charcoal and furniture. Private Land Timber Permits (PLTPs) were introduced in an effort to combat illegal timber poaching. However, very few communities have pursued the issuance of such permits as tenure security is a prerequisite for this. PLTPs are issued to a landowner for the cutting, gathering and utilization of naturally grown trees on private land.

Formulating participatory management agreements is just the first step toward addressing these problems. Stakeholders expressed concerns that even if forest land-use plans and comprehensive land-use plans (FLUPs and CLUPs) were introduced, their implementation and enforcement would be difficult. They thus made a call for thinking beyond the planning and drafting of documents to including a strong focus on implementation. Creating municipal multisectoral forest protection committees and strengthening law enforcement through paralegal training and other activities are some of the solutions that were proposed. More Municipal Environment and Natural Resources Offices (MENRO) are needed as well. The establishment of firewood plantations and briquetting activities, mainstreaming of efficient smokeless technologies, and support programs for alternative livelihoods were mentioned as additional solutions to address the charcoal challenge.

4.2.3 Low agricultural production and lack of alternative livelihood opportunities

Another interconnected group of challenges is that of limited agricultural production and livelihoods. The decline in abaca production, a major concern of communities in the province, was also stressed by

Figure 9. Group II presentation of challenges and solutions, Maasin City.
Photo by Gordon Bernard Ignacio/GIZ.

the province-level stakeholders. The introduction of new agricultural practices and crops as well as intercropping and agroforestry were proposed as effective solutions. The adoption of organic farming and agroforestry will not only address low harvests, but also the problem of declining soil fertility. In addition, production will be more resilient to different climate hazards. The low awareness of farmers about these techniques can be addressed through information and education campaigns and extension services led by the agricultural offices at the local level.

4.2.4 Disasters

Southern Leyte is perceived to be a disaster-prone province. Natural disasters such as flooding, landslides and forest fires, but also earthquakes and tsunamis, are considered critical threats. Low awareness about and public participation in disaster risk reduction were mentioned as underlying problems. As regards forest fires, for example, it is difficult to incentivize communities to engage in watchtower construction and patrolling if they do not have secure tenure rights over the resource that they are monitoring. Fire protection forms part of the CBFM and such agreements should be prioritized.

While hazard surveys and mapping are critical starting points for disaster preparedness, many municipalities still lack them. Disaster risk reduction (DRR) training should also be implemented at the local level. To facilitate the implementation of mapping, training, DRR planning and other proposed solutions a DRR office should be established in each municipality.

4.2.5 Other concerns and challenges

Other concerns and challenges that were voiced by the province-level stakeholders relate to infrastructure, waste management, river quarrying and high densities of crown-of-thorns starfish (*Acanthaster planci*) in coral reef areas. Infrastructure development is usually the top priority in LGUs, but more irrigation and potable water systems are needed, as well as farm-to-market roads. Appropriate infrastructure for waste management is also badly needed, as currently most municipalities utilize open dump sites. Sanitary landfills, such as the one found in the municipality of Silago, could be one solution. The provincial government has secured funds to hire a consultant to do a feasibility study of sanitary landfill construction sites. However, the conditions for constructing sanitary landfills are challenging, as limestone dominates throughout the province.

River quarrying constitutes another important problem as it aggravates flooding impacts and the overall ecological conditions of the rivers. Concessioners are currently allowed to quarry, but there is no proper regulation or monitoring. Awareness and education campaigns on the effects of quarrying and a quarrying permit system should be put in place.

Table 4. Province-level challenges and solutions.

Challenges	Proposed solutions
• Land tenure insecurity • Limited number of land use agreements and conflicting claims • Fuzzy land-use boundaries	Land-use planning; Formulation of FLUP–CLUP co-management agreements and land-use certificates (CBFMA, CSC); Dialogue and integration between agencies (DAR, DENR, LGU).
• Influx of migrants from lowlands to uplands • Encroachment of settlers into mangrove areas • Encroachment of agriculture into timberlands	Forest zone line survey and demarcation; Organize POs for issuance of CBFMA-CSC; Riparian zone establishment; Ridge-to-reef planning and convergence of programs.
• Illegal timber poaching and deforestation • Land-use conversion • Biodiversity degradation • Soil siltation (as a consequence of the above) • Wildlife hunting • Illegal fishing	Establish municipal multisectoral forest protection committee; Strengthen law enforcement and conduct paralegal training; FLUP–CLUP formulation and implementation; Reforestation and tree planting programs.
Resource degradation and health problems due to charcoal production	Same as above and additionally establish alternative livelihood programs, firewood plantations and briquetting, and new smokeless technologies.
No MENRO and lack of staff	Lobby for the establishment of MENROs and ask for budget allocation per LGU.
• Low agricultural production • Declining soil fertility • Low awareness on techniques and best practices • Decline of abaca production • Lack of alternative livelihood opportunities	Encourage intercropping, agroforestry and alternative crops; Adopt organic farming; Information and education campaigns on farming techniques; Alternative livelihood training and provision of financial assistance.
Natural disasters, including landslides, tsunamis, earthquakes, forest fires	Information and education campaigns on disaster preparedness and risk reduction; Hazard surveys and mapping; Establish fire lines and build capacity in forest management; Establish DRR office.
Poor infrastructure and solid waste disposal facilities	More infrastructure projects (irrigation, farm-to-market roads, potable water systems); Construct sanitary landfills; Constrain the use of plastics.
Negative impacts of river quarrying (e.g. flooding, sedimentation)	Conduct information and education campaigns; Establish permit system; Regulate and monitor.
High densities of crown-of-thorns (COT) starfish	Extraction and clean-up of reefs (with COT injector guns, etc.).

5. Climate and vulnerability analysis

5.1 Exposure

5.1.1 Past and current climate trends in Sogod

Average climate in Sogod

The average climate in Sogod presents a low mean seasonality in comparison to similar climates in other parts of the world. This means that, on average, seasons (whether hot or cold or dry or wet) are not marked. The mean monthly temperature ranges from 23.6°C to 25.4°C and precipitation from 147 to 351 mm/month.

According to the Coronas Classification, the main climate classification system used in the Philippines, the largest part of Sogod falls under Type II, which characterized by the absence of a dry season and months with the largest rainfalls between November and January (PAGASA 2011). A small part of Sogod, the western part of the province of Southern Leyte, falls under Type IV and has an even more evenly distributed rainfall throughout the year.

Interannual variability and trends of precipitation and temperature

The interannual variability of precipitation is high: 67% of the sites with similar climates in the world (with ± 1°C in annual mean temperature and ± 10% in annual precipitation) have lower variability. This means that Sogod has experienced exceptionally dry years (e.g. 1993–1994) and exceptionally wet years (e.g. 2001). The highest precipitation is recorded for the years 1996, 1999, 2000, 2001, and 2008. Despite the occurrence of exceptionally dry years, there is a significant trend in increasing precipitation (dotted line on the graph).

The Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) has also recorded evidence of a statistically significant

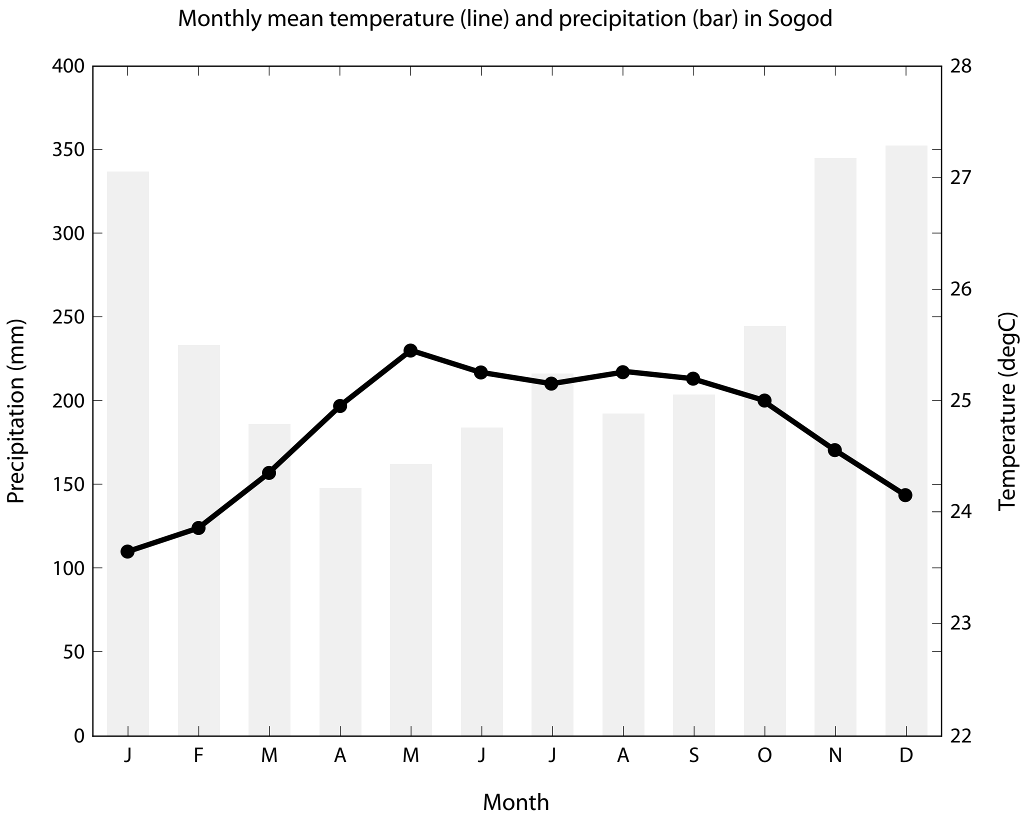

Figure 10. Average climate in Sogod: The line shows the average monthly temperature and the bars show precipitation.

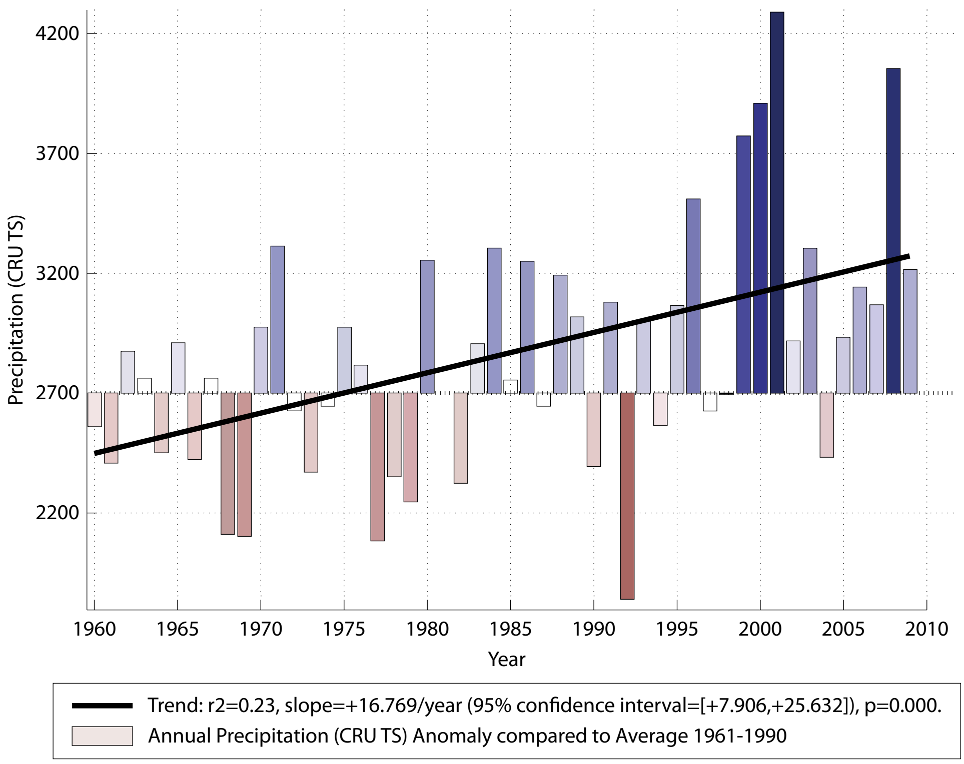

Figure 11. Variability of annual precipitation in Sogod, 1960–2010.

increase in rainfall from the observation station in Tacloban (PAGASA 2011).

On the other hand, the interannual variability of temperature is low (69% of sites with similar climates in the world have higher variability). However, there has been a trend in the increasing annual temperature mean of 0.13° per decade over the last 50 years. The 5 warmest years recorded are 1993, 1994, 1995, 1998, and 2000.

Literature on observed climate change and modeling related to Southern Leyte as well as the rest of the country confirms this general warming trend (Cruz et al. 2007; Sajise et al. 2010; Narisma et al. 2011; PAGASA 2011). The frequency of hot days and warm nights has increased and the number of cold days and cool nights has decreased. Furthermore, the PAGASA climate observation station in Tacloban has recorded upward trends in the frequency of days with maximum temperatures above the 1971–2000 mean 99th percentile.

5.1.2 Projected future climate trends

Futures of precipitation in Sogod

As in most tropical regions, the future precipitation in Sogod is highly uncertain. Depending on which GCM is used and the emission scenario, precipitation will either increase or decrease. The highest decrease projected is 370 mm less rain by 2080, while the highest increase is 330 mm. The average of the 16 scenarios shows an increase of 20 mm/year in 2080. Four scenarios show an increase of more than 200 mm, while two scenarios show a decrease of more than 200 mm in 2080. Ten scenarios show limited change (less than a 200 mm increase or decrease).

Concerns arise more with extreme wet or dry years (interannual variability) and extreme events than with the mean annual future precipitation of 2050 or 2080. However, climate models do not simulate interannual variability very well.

The future mean monthly precipitation is also uncertain. It should be noted, however, that there are points where most of the models converge. For example, according to most models, precipitation will increase in the period from mid-June to mid-September (Figure 14).

Other precipitation models and predictions

A regional climate modeling simulation conducted by PAGASA using PRECIS[9] and a

9 PRECIS, developed at the Met Office Hadley Centre, is a regional climate modeling system designed to run on a Linux-based PC. It can be applied to any area of

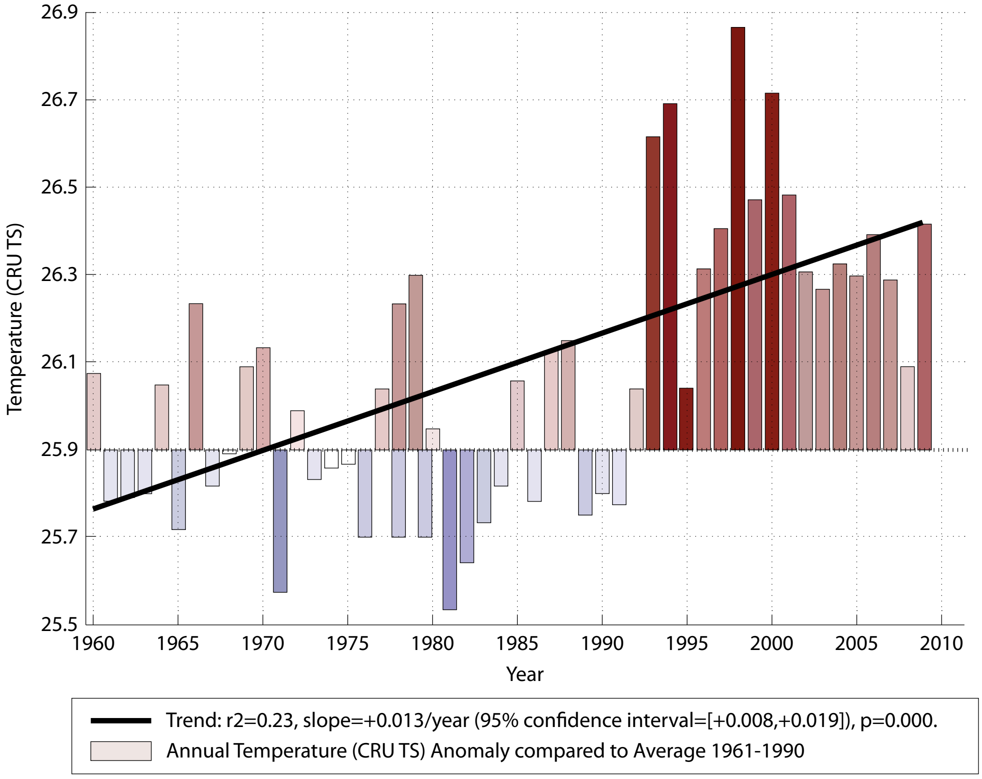

Figure 12. Variability of annual temperature in Sogod, 1960–2010

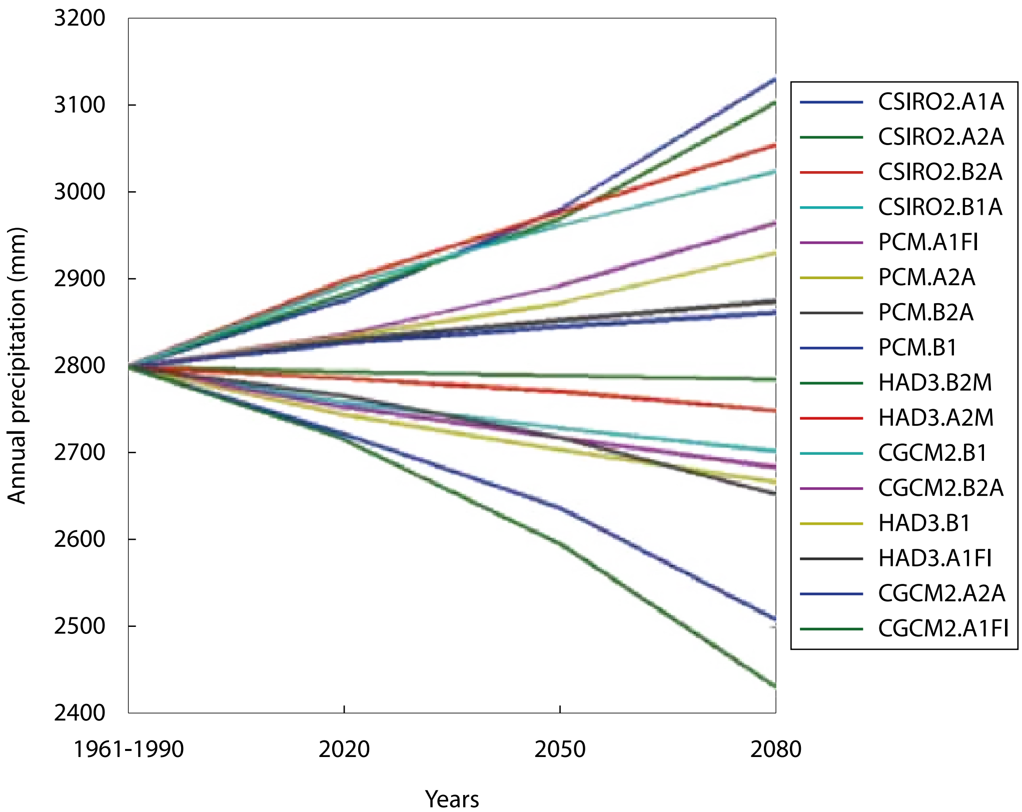

Figure 13. Future annual precipitation for Sogod for the years 2020, 2050 and 2080, according to 16 climate scenarios.

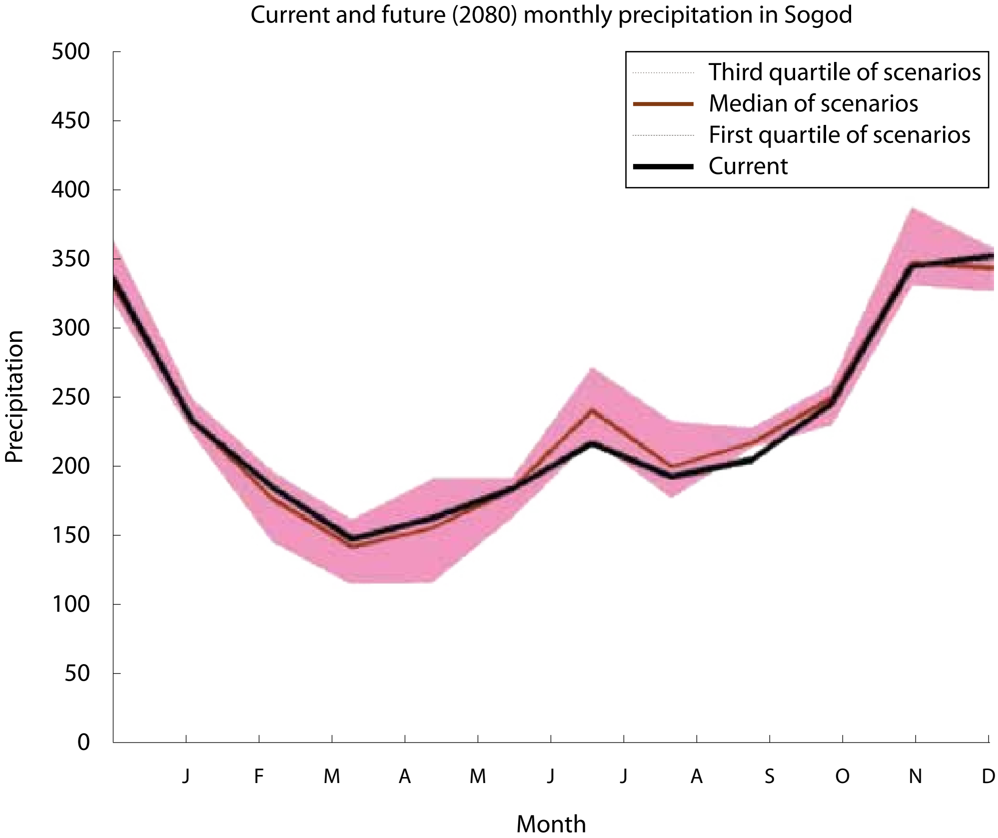

Figure 14. Predicted monthly precipitation in Sogod for 2080.

medium-range emission scenario indicate that the increasing frequency of days with extreme rainfall (>300 mm/day) that has already been recorded in the Tacloban and Maasin stations will intensify by 2020, and even more so by 2050. This agrees with the latest IPCC[10] report on extreme events (Field et al. 2012), which predicts with medium confidence that there will be more frequent and intense heavy precipitation days (precipitation >95th percentile) in Southeast Asia, including an increase in the 20-year return value of annual maximum daily precipitation rates (RV20HP).

For areas designated as having a Type II climate, the PAGASA PRECIS simulation indicates a reduction in rainfall during the summer (MAM) season of 5–10% of the monthly average up to 2020 and 10–20% up to 2050. However, rainfall will likely increase by 5% until 2020 during the southwest monsoon (JJA) season until the transition (SON) season begins, and by 10–30% by 2050. Rainfall is also likely to increase by 5–10% until 2050 during the northeast monsoon (DJF) season.

Future of annual temperatures in Sogod

The future annual mean temperatures in Sogod are more certain. All models show an increase in temperature of:

- at least 0.42°C (model predicting the lowest increase) to 0.85°C (model predicting the highest increase) by 2020;
- 0.71°C (min) to 2.02°C (max) by 2050; and
- 0.96°C (min) to 3.66°C (max) by 2080.

This increase is a concern for Sogod, especially since the interannual variability of temperature has been low in the past (around 2°C difference in annual average temperature between warmest and coldest years in the past 25 years). Heat waves and increases in daily maximum and minimum temperatures are of great concern.

The PAGASA PRECIS simulation predicts a drastic increase by 2050 in the number of days where the maximum temperature exceeds 35°C in Southern Leyte (PAGASA 2011). In relation to the observed baseline from the station at Maasin, which recorded

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the globe to generate detailed climate change projections (http://www.metoffice.gov.uk/precis/).

10 Intergovernmental Panel on Climate Change http://www.ipcc.ch/.

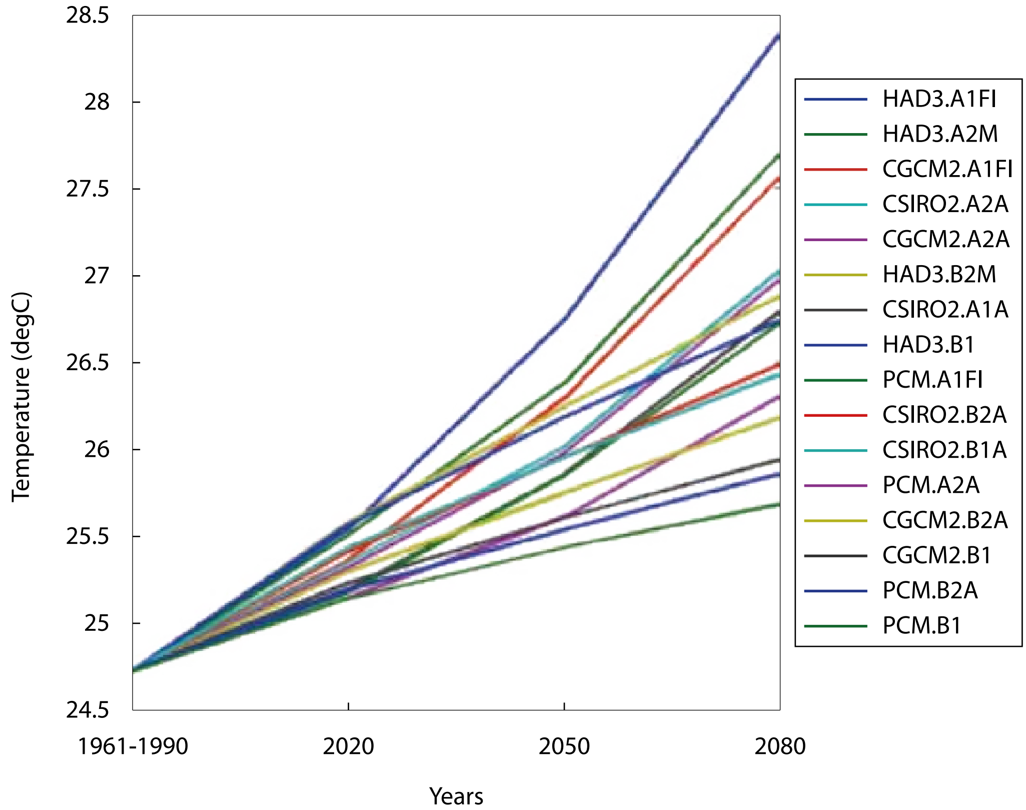

Figure 15. Future temperature models for Sogod for the years 2020, 2050 and 2080.

a total of 130 days with Tmax > 35°C during 1971–2000, the frequency of extreme temperature days will increase drastically with a projected total of 764 days of Tmax > 35°C by 2050.[11] The IPCC has high confidence that this trend of an increasing number of warm days and a decreasing number of cool days will occur all over Southeast Asia.

The same trend is projected by regional climate modeling for the neighboring municipality of Silago (Narisma et al. 2011). Warmer days and nights should be anticipated by the 2020s and 2050s. In the 2020s, Silago will have more years with more than 120 days per year of Tmax > 32.6°C. Extremely high maximum and minimum temperatures (90th percentile of the baseline period 1961–1990) could last throughout the year in the 2050s. All years in this decade are simulated to have only up to 30 days per year where the daily maximum temperature is less than 26°C. There will be a maximum of only 60 days per year with cool nighttime temperatures lower than 22.6°C. Most of the nights will be warmer, with temperatures greater than 25°C predicted.

11 Total expected for the time frame 1971–2050.

Extreme events

There is scientific consensus that climate change makes particular types of extreme events more likely, such as droughts and heat waves (Field et al. 2012; Peterson et al. 2012). However, because of natural climate variability, whether or not this likelihood will increase and by how much it increases, is difficult to estimate (Peterson et al. 2012). Due to climate change, however, extreme events will become more unpredictable and their patterns, intensity and locations are likely to be altered.

Tropical storms and cyclones

The occurrence of extreme climate events is nothing extraordinary for the Philippines. On average, 20 tropical cyclones enter the Philippines area of responsibility (PAR) each year, with 9 of them making landfall in the country (Sajise 2012). There has been no significant difference in the number of cyclones forming in or entering the PAR during the last 58 years, but typhoons have become more hazardous due to an increase in their strength (Sajise 2012).

An analysis of data from 1948 to 2005 shows that tropical cyclones with velocities greater than 150 kph are on the rise, while strong cyclones are more frequent during El Niño events (Anglo 2006). Regions where storms made landfalls have also changed. In previous years, typhoons predominantly affected the Eastern Visayas region, but recent typhoons (e.g. Frank) have caused havoc in the Western Visayas. Typhoons such as Ondoy and Peping have also been veering toward Northern Luzon (Sajise 2012).

How typhoon tracks are projected to change remains uncertain. Their intensity though is highly likely to increase. According to the IPCC, tropical cyclone intensity is projected to increase from 10 to 20% in Southeast Asia for the expected rise in sea-surface temperature of 2 to 4°C (Cruz et al. 2007). The impacts of an increase in cyclone intensity in any location will be determined by any shift in the cyclone tracks (Kelly and Adger 2000).

El Niño–Southern Oscillation (ENSO)

ENSO events are also expected to result in more extreme droughts and precipitation events with climate change. ENSO events alternate between El Niño and La Niña. During El Niño years, unusually warm water forms across much of the tropical eastern and central Pacific, resulting in a drastic decrease of precipitation over Southeast Asia. La Niña is the counterpart to El Niño, and La Niña years are characterized by cooler than normal sea-surface temperatures across the equatorial eastern and central Pacific, resulting in intense precipitation (IRI 2007). ENSO events are a normal part of the Earth's climate (ENSO is the most dominant feature of cyclic climate variability on subdecadal timescales), and they have been occurring for hundreds of years (Yeh et al. 2009). The time between successive El Niño events is irregular, but they typically tend to occur every 2–4 years (high-frequency oscillation period) or every 4–6 years (low frequency) (An and Wang 2000). A La Niña event often follows an El Niño and vice versa, although this is not always the norm. ENSO events last for roughly a year, although occasionally they may persist for 18 months or more (IRI 2007).

Even though the future frequencies of ENSO events under climate change cannot be predicted with accuracy, several analyses show that ENSO will transition from a stable oscillatory behavior to an unstable one with changes in amplitude, structure and frequency (Timmermann 2001). Some projections indicate that ENSO events will only occur in high frequency (every 2–3 years) after the 2050s (Sofian 2010). This oscillation instability is already noticeable in recorded data from the 1980s onwards, showing more frequent and intense ENSO events (IRI 2007).

Conclusion/summary

1. Increase in temperature
    - Means (annual + seasonal)
    - Days with Tmax > 35°C
2. Possible increase in precipitation
    - Means (annual + seasonal) except in MAM
    - Heavy precipitation days > 300 mm
3. Unpredictable and intense extreme events
    - Typhoons
    - El Niño and La Niña
4. More intense variability in climate in general (temporal and spatial)
5. Influence of land surfaces and change (difficult to predict for inclusion in models)

5.2 Sensitivity

5.2.1 Agricultural production

Rice

Both rainfed and irrigated rice are sensitive to a number of climate variables such as precipitation, vapor pressure, soil moisture, seasonal temperature, daily maximum and minimum temperatures, solar radiation and the annual input of atmospheric CO_2 concentration (Wassmann et al. 2009; Lansigan et al. 2000). Both long-term changes in climate and its variability (e.g. rise in annual temperature means) and short-term weather events (e.g. drought) influence rice production and yield. The effects of short-term events and extremes on yield largely depend on the development stage of the crop at the time of exposure (Lansigan et al. 2000).

There will be some positive effects of a CO_2 increase on rice productivity and yields, but these effects will be nullified by the negative impacts of a temperature rise (Baker et al. 1992). The optimum temperature for most rice growth stages is in the range of 25–30°C.

High temperatures induce sterility during highly sensitive physiological processes such as anther dehiscence and the early events of fertilization. Anthesis (flowering) in rice is extremely sensitive to high temperature, and spikelets opening during the flowering period will be affected profoundly depending on the duration of exposure (Wassmann et al. 2009). Future projections indicating more days with Tmax >35°C are thus of great concern.

Growth stages	Critical temperature (°C)		
	Low	High	Optimum
Germination	16–19	45	18–40
Seedling emergence	12	35	25–30
Rooting	16	35	25–28
Leaf elongation	7–12	45	31
Tillering	9–16	33	25–31
Initation of panicle primordia	15	–	–
Panicle differentation	15–20	30	–
Anthesis	22	35–36	30–33
Ripening	12–18	> 30	20–29

Figure 16. Critical temperatures for rice development at different growth stages after Yoshida (1978).

High temperature influences the ripening phase as well by affecting cellular and developmental processes, ultimately leading to reduced fertility and poorer grain quality (Barnabás et al. 2008). Common effects of exposure during this stage include decreased grain size and weight, reduced grain filling, and higher percentages of white chalky and milky rice, all of which reduce the economic benefits farmers can derive from rice cultivation (Wassmann et al. 2009).

Rice is highly sensitive to increases in the minimum daily temperature (nighttime temperature). Studies in Nepal have shown that an increase in the minimum daily temperature has a more deleterious impact than an increase in the maximum daily temperature as regards high rice yields (Rai et al. 2012). In the Philippines, grain yield has been shown to decline by 10% for each 1°C increase in the growing-season minimum temperature during the dry cropping period (Peng et al. 2004).

The rice crop is also sensitive to variability in both the amount and distribution of rainfall. In the freely drained uplands, moisture stress severely damages or even kills rice plants in areas that receive as much as 200 mm of precipitation in 1 day and then receive no rainfall over the next 20 days (Nguyen n.d.). Flooding constrains rice production in the lowlands too. Excessive water at the vegetative growth stage hampers rooting and decreases tiller production. Although rice is a semi-aquatic plant, it is generally intolerant of complete submergence, and plants die within a few days if completely submerged (Wassmann et al. 2009). Most rice varieties can tolerate complete submergence for about 6 days before 50% of the plants die. The mortality rate becomes 100% when submergence lasts for 14 days or more, although there are a few varieties that can survive the 14-day threshold (Nguyen n.d.; Wassmann et al. 2009).

On the other hand, drought during flowering causes spikelet sterility and major yield losses (Ekanayake et al. 1989; O'Toole and Namuco 1983; Wassmann 2009). Soil water deficit in general influences all the physiological processes in rice plant growth and development (Wassmann et al. 2009), with drought being the biggest production constraint in rainfed rice systems, affecting 10 million ha of upland rice and more than 13 million ha of rainfed lowland rice in Asia (Pandey et al. 2007).

More frequent and intense ENSO events related to both El Niño and La Niña will thus impact rice production immensely due to either drought and temperature increases or heavy precipitation and flooding. The incidence of pests and diseases will also be aggravated by fluctuations in climate variables (Lansigan et al. 2000). Studies in Indonesia have shown that rice areas affected by the brown plant hopper tend to increase significantly during the prolonged precipitation of La Niña years (Susanti et al. 2010).

Abaca and banana

Abaca (*Musa textilis* Née), also known as "Manila hemp," is closely related to the edible banana and is indigenous to the understory of tropical evergreen rainforests in the Philippines (Bande 2012). It is grown almost exclusively for its fibers, which are a profitable commodity. The plant grows best on fertile volcanic or alluvial soils with good moisture retention, and it requires an evenly distributed annual rainfall of 2000–3000 mm, a relative humidity of about 80%, and a temperature range of 20–27°C for optimum growth (Vaughan 2011; Weidner et al. 2011; Bande 2012). It does not tolerate drought, waterlogging or strong winds. Physiological activity decreases after even short dry periods, while strong wind speeds impact physiological functioning directly and induce mechanical damage to the plant (Bande 2004).

High temperature and solar radiation significantly affect the morphological and physiological performance of the crop, especially when grown in full sunlight. When abaca is exposed to mean temperatures above 27°C, the plant becomes stunted and chlorotic and fiber yields start dropping significantly (Bande et al. 2013).

Similarly to abaca, bananas need sufficient water uniformly distributed throughout the year and grow optimally at a temperature range of 24–27°C (Jarvis et al. 2012). Growth and development of the banana crop is impaired by temperatures outside of this range. Research has shown that the crop suffers heat injury at minimum (nighttime) and maximum (daytime) daily temperatures of 30°C and 37°C respectively (Turner and Lahav 1983). High temperatures lead to lower unit leaf rates and less dry matter in the roots and corn as compared with plants grown under optimum daily minimum and maximum temperatures of 18 and 25°C. In general, productivity and yields start decreasing above the optimum temperature of 27°C, as with abaca (Sastry 1988).

Climate variables are also shown to affect disease epidemics in the abaca and banana crops. The bunchy top virus (abaca bunchy top, ABTV; and banana bunchy top, BBTV), transmitted primarily by the aphid *Pentalonia nigronervosa*, is the most important biological production constraint for both abaca and bananas in the Philippines (Dizon et al. 2012). Increasing temperatures could allow the aphids to reproduce for longer and to reach their minimum flight temperature sooner, leading to increased dispersal of the bunchy top virus. The reproductive rate of the aphid at 26–29°C and 63–75% relative humidity is 1–4 nymphs/female per day, and it has a developmental time of 6–21 days at this temperature range (Raymundo and Bajet 1998; Raymundo 2000). Aphid development at higher temperatures under climate change is still uncertain, but the consequences could be dire for the susceptible crops.

Pentalonia nigronervosa has limited migratory tendencies, preferring to live in colonies under the shelter of abaca or banana, and virus spread due to the active dispersal of the aphid is thus very slow. Virus spread over longer distances happens quickly when there are strong winds that act as agents of aphid dispersal. A big part of this extended dispersal phenomenon has been attributed to the gusty winds that occur during the passage of typhoons (Raymundo and Bajet 1998). Storm events thus have a direct influence on the bunchy top disease epidemics in abaca and banana plantations.

Root crops

Although the optimum temperature for cassava (*Manihot esculenta*) is in the range of 22–32°C (Lebot 2009; Jarvis et al. 2012), this root crop is exceptionally tolerant of higher temperatures and drought. It can survive temperatures of up to 45°C and an annual mean rainfall of only 300 mm (Jarvis et al. 2012), but it is not tolerant of waterlogging (Lebot 2009). Furthermore, cassava has a high sensitivity to pests and diseases (Herrera Campo et al. 2011). The four principal biotic constraints to cassava production are whiteflies, cassava green mites, cassava mosaic disease and cassava brown streak disease, with the majority of Southeast Asia constituting a hot spot for pest and disease outbreaks (Herrera Campo et al. 2011). Higher temperatures are very likely to result in increased outbreaks, and thus a strong focus needs to

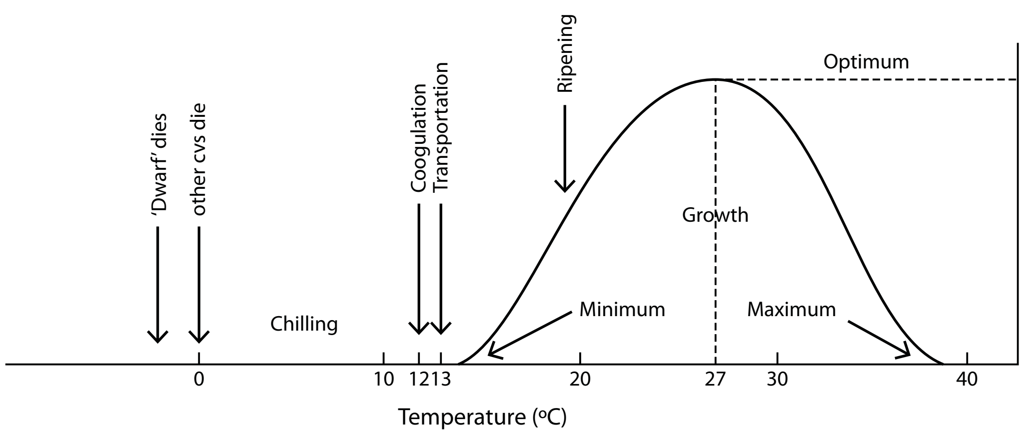

Figure 17. Relationships between temperature and banana growth processes.
Source: Deuter et al. (2012) after Sastry (1988).

be put on pest and disease management for cassava to thrive under climate change (Ceballos et al. 2011; Jarvis et al. 2012).

Like cassava, sweet potato (*Ipomoea batatas*) is drought resistant and can grow in harsh conditions in poor soils (Lebot 2009). It is highly tolerant to weeds and has relatively few natural enemies. However, it is even less tolerant of waterlogging than cassava and needs to be harvested and stored before heavy rains start (Lebot 2009). An increase in annual precipitation and heavy rainfall days will make sweet potato cultivation difficult.

Taro (*Colocasia esculenta*), on the other hand, can be grown in very wet areas where annual rainfall exceeds 2500 mm, on both alluvial flat plains as well as on fertile hillside slopes (Kantaka 2004; Manner and Taylor 2011). Taro will thrive on waterlogged soils, especially those that are saturated for long periods. But like many root crops, the most critical problem for taro is susceptibility to pests and diseases, which are likely to be aggravated with climate change.

Coconut

Coconut (*Cocos nucifera*) productivity is more sensitive to short-term climate variability such as summer droughts than to climate change in terms of increased annual temperature means (Krishna 2012). During the 1997–1998 El Niño events in the Philippines, coconut production did not appear to have been severely affected (Narisma et al. 2011), although the drought effects were frequently only felt in the years following exposure (Krishna 2012). The occurrence of a dry spell in 1 year can affect the yields for the subsequent 3–4 years, with the degree of impact depending on the development stage of the crop at the time of exposure and the postdrought climatic conditions. However, exceptionally long dry spells have been found to affect nut yields significantly during even the fourth year post exposure, irrespective of the total rainfall received after the event (Krishna 2012). The length of the dry spell is crucial during critical development stages of rainfed coconut such as primordium initiation, ovary development, and button-size nut stage.

The optimum temperature for coconut growth is a mean annual average temperature of 27°C (Krishna 2012). Good growth can still be achieved with mean summer temperatures of 28–37°C. However, maximum daily temperatures and relative humidity in the afternoon are two variables that can influence coconut yields significantly, depending on the crop development stages at exposure (Peiris and Thattil 1997). In Sri Lanka, for example, high air temperature and low relative humidity in the afternoons during the fourth month of fertilization have been shown to increase the immature nut fall of the bunches that opened during November and December (Peiris and Thattil 1997). The climate during February, June, July, September, and December is the most critical with respect to yields in Sri Lanka. Rainfall shortages during February were found to be the most influential in terms of total yield, although excess rainfall during May–August and November–December depresses yields significantly (Peiris and Peries 1993). Studies on coconut sensitivity to climate during different development stages are unfortunately unavailable for the Philippines.

Other variables found to affect coconut yield are wind velocity (Peiris and Thattil 1997) and cloud cover (Krishna 2012). Sunshine hours and evaporation have shown a positive correlation with yield whereas relative humidity has shown a negative correlation (Nair and Unnithan 1988). There could be a 50% reduction in potential photosynthesis when light intensity is reduced to only 20% of the normal clear-day intensity in tropical areas at 10°N (De Wit 1965 *in* Krishna 2012). In conclusion, both drought and excess rain and cloudiness are climate variables to which coconut crops can be very sensitive. ENSO events and climate extremes are thus high-risk periods for yield decrease, even several years after exposure.

5.2.2 Forests

Forests and trees are less sensitive than agricultural crops to climate variability and extreme events, and CO_2 accumulation can even be beneficial for their productivity. However, longer-term climate change could alter the structure and composition of forests across the country. Forests in the Philippines fall under the types of dry forest, moist forest, and wet forest. The dry forests are the most vulnerable as they could disappear even with only a 25% increase in rainfall (Lasco et al. 2008). However, studies on forest sensitivity and vulnerability to climate change in the Philippines are just beginning and the knowledge gaps are immense.

Thousands of hectares of second-growth and logged-over forests were burned in the Philippines during the 1997/98 ENSO events (Cruz et al. 2007).

Several studies, predominantly from Indonesia and the Amazon region, have demonstrated the sensitivity of tropical forests to drought events associated with El Niño. ENSO events increase the risk, intensity and spread of forest fires due to the rise in temperature and the decline of precipitation, especially in disturbed forests.

Under normal rainfall and humidity conditions, most of the fires (both naturally occurring and anthropogenic) are extinguished with the arrival of the monsoon or rainy season. The moist microclimate within intact tropical evergreen forests will usually not sustain fire (Roberts 2000). Forest fragmentation and changes in land use have, however, resulted in canopy discontinuity, allowing sunlight to penetrate and dry the forest leaf litter, decreasing the overall humidity retention. As a consequence, there is a build-up of highly-flammable, available fuel (Roberts 2000). Forest remnants are heavily degraded by logging and have dry, fire-prone edges, something which further increases forest desiccation and fuel loading (Cochrane and Laurance 2002).

Forest sensitivity to fire increases with repeated fires, leading to positive feedback loops. Forest fires in the Amazon, for example, usually have a moderate fire-line intensity of less than 50 kW/m^2. Post fire, however, highly flammable fuel builds up from dead tree stands, colonizing grass species and leaf-shedding, directly increasing the severity of any secondary fires (Cochrane and Schulze 1998). This also occurred in the Sumatran lowland tropical forests where El Niño fires led to mass dieback and collapse of trees and to a dominance of softwood pioneer species, which has heavily increased the risk of future fires (Kinnaird and O'Brien 1998). The average rate and intensity of forest burning and deforestation will increase as previously burned forests accumulate (Cochrane et al. 1999). Burned forests also become sensitive to heavy precipitation which leads to soil erosion and nutrient leaching because of the poor interception of rainfall by the damaged canopy.

Drought also causes mortality in trees, especially if the drought is long lasting. Dipterocarp-dominated forests in Kalimantan, Indonesia, similar to the forests found in Southern Leyte, presented high tree mortality after the drought of the 1997–1998 El Niño event. While fire mainly killed trees with a small stem diameter, drought caused mortality in trees of larger stem diameters. Trees died either because of energy reserve exhaustion caused by decreased photosynthesis or because of an inability to recover after hydraulic failure (van Nieuwstadt and Sheil 2005).

In the Sungai Wain forest of Kalimantan (presenting a similar annual precipitation average as Sogod), mortality rose to 20–26% among trees with a diameter at breast height (d.b.h.) greater than 10 cm 2 years after the drought, while species-specific mortality among trees with a d.b.h. greater than 30 cm varied tenfold, thus leading to an alteration in species composition (van Nieuwstadt and Sheil 2005). However, fire-induced tree mortality cannot easily be distinguished from drought die-back, as fires strike only during drought events at a time when drought mortality is still ongoing.

There is a concern that projected drought conditions in the municipality of Silago, which borders Sogod, will affect the inland forest ecosystems and increase the likelihood of fire, especially in the forest edges where many disturbances are occurring at the same time (Narisma et al. 2011).

5.2.3 Health

A number of infectious bacteria and vectors causing diseases in the Philippines are climate sensitive, and changes in temperature and precipitation are highly likely to increase their spread. While infections causing diarrheal diseases are linked to poverty and hygiene behavior, they are also compounded by the effect of high temperatures on bacterial proliferation (Checkley et al. 2000). Several studies have demonstrated the link between El Niño events and the increase in community diarrhea rates, especially among children (Checkley et al. 2000; Bennett et al. 2012). Precipitation increase and frequent floods will also lead to more gastrointestinal diseases and other waterborne infectious diseases such as dermatosis because of the degradation of surface water quality and the increase in pollution (Cruz et al. 2007).

Greater rainfall, in combination with warmer temperatures and poor sanitation, is projected to expand the vectors for malaria and dengue fever across Southeast Asia (Cruz et al. 2007). By 2085, approximately 6 billion people globally will be at risk of dengue transmission as a consequence of climate change, which is 2.5 billion more than if the climate were to remain unchanged (Hales et al. 2002). In the Philippines, positive correlations have been found between increased monthly precipitation and the number of dengue cases (ADB 2011). Dengue is currently not a threat to health in Southern Leyte and Sogod, but with rising temperatures and precipitation this could change in the future if no measures are taken.

5.2.4 Summary and conclusion

Both agricultural production and forests are sensitive to variability in climate, extremes, and longer-term climate change. Rice is very sensitive to high temperatures, especially at critical development stages, and to both increases and decreases in precipitation. Abaca and banana need abundant rainfall, with production decreasing at temperatures above 27°C, while cassava thrives in drought conditions at 32°C. Sweet potato is drought-resistant but cannot tolerate waterlogging, while coconut cannot tolerate extended cloudiness. Tropical rain forests are prone to drought-related mortality and fires during El Niño events.

The degree of sensitivity, however, is influenced by other destabilizing pressures and feedback loops. Forests, for example, are more sensitive to drought events and fires if they are degraded or logged (Roberts 2000). Crops are more sensitive to increases in temperature, precipitation, drought and pest outbreaks if they are produced through monocultures and in degraded soils in comparison to more complex systems or agroforestry (Verchot et al. 2007; Garrity 2010; Pramova et al. 2012). Poor sanitation and pollution, as well as riverbank and watershed degradation, increase the severity of flooding events and the proliferation of bacteria and vectors during heavy precipitation (Cruz et al. 2007). Enhanced and sustainable environmental management can decrease sensitivity, and ultimately impacts almost all sectors and systems.

5.3 Adaptive capacity

As mentioned above, examples of resources affecting adaptive capacity include irrigation infrastructure and weather stations (physical), community savings groups and farmer organizations (social), reliable fresh water sources and productive land (natural), micro-insurance and diversified income sources (financial), and knowledge, skills and education (human).

Although natural resources are available in the upland barangays of Sogod, access to them is not secure. People use forest resources to cope with disturbances to their livelihoods (e.g. by selling rattan products to supplement income), but there are no proactive resource management strategies for enhanced adaptation over time. Diversification of activities within and outside of agriculture is also low, as evidenced by the findings of the socioeconomic baseline study for piloting REDD+ activities in Southern Leyte (Armenia et al. 2012). The majority of the households both within and outside of the REDD+ project areas do not have any off-farm income. This leaves people vulnerable to crop failure.

Furthermore, there is little presence of agricultural infrastructure in the area, such as grain storage and irrigation facilities, and no weather stations in the proximity of Sogod, all of which could help prevent crop failure, income loss and food insecurity. Future yield losses and crop failure could also lead to more exploitation of vulnerable forest resources that lack management.

Although intercropping of abaca and other crops with fruit and timber trees can be beneficial both in terms of decreased system sensitivity and economic diversification, agroforestry systems are not widespread. Monocropping is the dominant cropping system observed in the farm parcels of Southern Leyte (Armenia et al. 2012). The reluctance of farmers to plant trees outside of the occasional participation in government reforestation programs could be partially explained by the insecure tenure that they have over the land. Almost 90% of the households interviewed for the REDD+ socioeconomic study also declared that they have no tenure over the land that they utilize (Armenia et al. 2012). Other reasons inhibiting farmers from planting trees include general unavailability of land, the need for immediate income streams versus the longer-term return obtained from planting trees, and the perception that trees affect coconut production due to shading and nutrient competition.

Social organizations are also lacking for the majority of the barangays. Of the 7 barangays that participated in the community workshop, only 2 have a PO (San Vicente and Kauswagan), while only 1 barangay (Benit) has a microfinance institution present in the vicinity. Similarly, almost all of the respondents of the REDD+ socioeconomic study reported that they are not aware of the existence of credit and/or related financial services being made available in the barangays. Only informal sources of credit are available, such as private money lenders and traders, to whom households resort in time of need (e.g. after a disaster or harvest failure). Private lenders, however, charge high interest rates.

With regard to transport infrastructure (e.g. roads and bridges), the situation is dire in almost all of the barangays. This limits the capability to reduce disaster risks and to evacuate effectively during extreme events such as flooding. Some barangays even lack potable water infrastructure. More than 20% of the total households in Sogod Municipality do not have potable water systems (Armenia et al. 2012). During the community workshop in Sogod, barangay Kahupian mentioned that they have no potable water systems in general, while barangays Santa Maria and Benit reported that they have no potable water during times of drought. This lack of adequate fresh water systems and waste management facilities further increases the risk of diahrreal disease epidemics.

Policy structures do exist, however, to help local governments (LGUs) plan for adaptation and disaster risk reduction and tap into financial and technical resources. But these policy developments remain largely unknown at the barangay level, as reported during the REDD+ socioeconomic baseline study (Armenia et al. 2012).

5.4 Adaptation policy

In 2009, the Government of the Philippines passed Republic Act 9729, the Climate Change Act, with which it established the legal and institutional framework for climate change governance in the country and for mainstreaming climate resilience across government agencies and economic sectors (Lofts and Kenny 2012). The Act calls for climate change interventions to be closely linked to economic targets, social development and environmental integrity. The Act also created the Climate Change Commission (CCC), with the President as the Chair and with three commissioners, one of them being the Vice-Chair, as the sole policy-making and oversight authority with regard to climate change. The Commission's main function is to ensure the synergistic mainstreaming of climate change and disaster risk reduction into the national, sectoral, and local development plans and programs. It replaced the overlapping mandates of the Inter-Agency Committee on Climate Change and the Presidential Task Force on Global Warming and Climate Change. Activities of the Commission include, for example, the development of climate change technical units in different government agency departments, like the one already developed in the Department of Health.

The Commission led the development of the National Framework Strategy on Climate Change (NFSCC) in 2010 and the National Climate Change Action Plan (NCCAP) 2011–2028, which was signed by the President in November 2011. The Framework Strategy serves as a roadmap for increasing the country's social and economic adaptive capacity, the resilience of its ecosystems, and the best use of mitigation and finance opportunities. The Action Plan outlines programs of action for climate change adaptation and mitigation, focusing on seven priority areas: food security, water sufficiency, ecosystem and environmental stability, human security, sustainable energy, climate-smart industries and services, and knowledge and capacity development. The initial implementation period of 2011–2016 targets the elaboration of vulnerability assessments and the development and funding of "ecotowns" at the LGU level. These incorporate disaster risk reduction, sustainable livelihoods and environmental management and adaptation. The Philippine National REDD-plus Strategy (PNRPS) is integrated in the NFSCC as an important element for mitigation and adaptation. The implementation of the PNRPS is also part of the NCCAP and the Philippine Development Plan 2011–2016.

The frontline agencies for local planning and implementation are the LGUs (DILG 2012). The NCCAP provides guidance for LGUs to formulate, implement and regularly update Local Climate Change Action Plans (LCCAPs) that are tailored to the needs, challenges and opportunities emerging within local communities. The Commission is mandated to help the LGUs meet the human resource, technical, and financial challenges for LCCAPs through capacity building, direct financing and mechanisms such as payments for ecosystem services. The Department of Interior and Local Government (DILG) is one of the agencies responsible for assisting the LGUs. With regard to financing, the LGUs are also expected to redirect a portion of their annual internal revenue allotment to the LCCAPs. The Climate Change Act additionally requires government financial institutions to provide LGUs with preferential loan packages for climate change activities separate from the internal revenue allotment.

The Collaborative Programme on Philippine Climate Risk Reduction, which the Commission established with the National Disaster Risk Reduction and Management Council, harmonizes LCCAP requirements with those of Local Disaster Risk

Reduction and Management Plans under the Disaster Risk Reduction and Management Act of 2010. This Act, through the National Disaster Risk Reduction and Management Council, aims to mainstream disaster risk reduction into sustainable development and poverty reduction strategies, policies, plans, and budgets at all levels.

The Disaster Management Assistance Fund administered by the Department of Finance offers loans to LGUs at low rates (3–5%). In addition, general appropriations, the national budget and the internal revenue allotment of LGUs have financed the Local Disaster Risk Reduction and Management Fund. The People's Survival Fund created by an amendment of the Climate Change Act through Republic Act 10174 in July 2012 is foreseen to provide another source of financing for climate change adaptation programs. Financing for this fund is expected to be generated from foreign and local sources, such as proceeds from the sale of carbon credits, motor vehicle taxes and bilateral or multilateral sources. The fund can be tapped directly by local government units and communities to support their initiatives to adapt to climate change and reduce disaster risks.

6. Community-based adaptation interventions

6.1 Community priorities for the future

The two top aspirations that emerged from the voting are (i) restored abaca production and livelihoods (22 votes) and (ii) secure land tenure, also over farm lots and other production areas (19 votes).

The community members were then asked to plan two community interventions based on the top two priority aspirations, but also taking into account the other desired future characteristics wherever possible.

6.2 Selected interventions

Following the priority aspirations, the two adaptation interventions that were planned in break-out groups were (i) restoring abaca production and related livelihoods, and (ii) securing land tenure.

Table 5. Priority voting on aspirations for the future.

Aspiration	Total no. of votes
Restored abaca production and related livelihood activities (e.g. weaving, rope-making, etc.).	22
Land tenure is secured. Farmers have security over their farm lots and other production areas (e.g. agroforests). CSCs are issued.	19
Coconut production is diversified (beyond copra) and products are marketed effectively.	10
Forest cover is restored, especially on barren lands, and flood and landslide risk is reduced.	10
New infrastructure is in place, especially farm-to-market roads and bridges, and is well-maintained.	8
More college graduates and professionals are present in the barangays (e.g. doctors, police officers, etc.).	6
Barangays have active and capacitated People's Organizations.	5
Ecotourism activities are developed to protect wildlife and provide alternative livelihoods.	3
Freshwater tank systems are present and water supply is secure.	3

6.2.1 Securing land tenure

The intervention for securing land tenure was planned assuming that 430 households will be involved (this represents the total number of households from barangays Benit, Hipantag, Kauswagan, San Juan, San Vicente and Santa Maria). Mr. Gordon Bernard Ignacio, senior advisor with the GIZ Philippines and the REDD+ pilot activities in Southern Leyte, assisted the land tenure break-out group through all the necessary steps that must be undertaken to obtain tenure certificates.

Tenure will be secured by obtaining a CBFMA and/or CSCs. A CBFMA has a duration of 25 years (renewable for another 25 years) and is designed with the main objective of ensuring that communities benefit fully from the sustainable management, conservation and utilization of forest lands and natural resources therein without entering or paying for any rental agreements. It recognizes the individual rights of occupancy through the granting of CSCs that are conterminous with the CBFMA. The CSCs are issued by the CENRO upon recommendation of the relevant PO based on the census of forest occupants provided that the area is part of the CBFM and the applicant is a PO member.

There are two possible options to secure land tenure within state-owned forestlands after the LGU has formulated its Forest Land Use Plan (FLUP). The first is through the CBFM strategy whereby the DENR and LGU organize the upland farmers into a PO and issue a 25-year communal tenure instrument, CBFM agreement, when they meet all requirements. The PO, with the help of DENR and LGU, then formulates the 25-year community resource management framework (CRMF).

The CRMF is a strategic plan for the management and benefit sharing of the forest resources on a sustainable basis. It describes the community's long-term plans for the protection, rehabilitation, development and utilization of forest resources, including the identification and establishment of livelihood enterprises. It is supplemented by the detailed 5-year work plan of POs toward achieving the outlined goals. The CRMF, once affirmed, also serves as the Initial Environmental Examination for CBFMA, which describes the environmental impacts of, and mitigation and enhancement measures for, activities to be undertaken in the area. The development and management of CBFM areas can then begin, in conformity with the CRMF.

The formulation and implementation of the PO plans entails CENRO and LGU assistance in delineating boundaries, conducting resource surveys, developing and implementing benefit-sharing mechanisms, and protecting, rehabilitating and conserving natural resources (DENR 2004). Based on the areas determined for agroforestry or individual farm development, the PO can also recommend to the DENR the issuance of individual CSCs.

The other option is through a comanagement agreement (CMA) between the DENR and LGU, where a comanagement subagreement could be awarded to families or households for the development (e.g. through tree planting, agroforestry) and protection of certain areas as determined in the Forest Land Use Plan (FLUP). This option, however, is temporarily on hold pending the finalization and approval of the revised joint memorandum circular on comanagement.

Following the approval and registration of the CBFMA process, the POs should prepare a Community-Resource Management Framework (CRMF) and a 5-year work plan. The LGU and also CENRO, PENRO, RENRO are mandated to assist the POs in this planning activity (DENR 2004).

6.2.2 Restoring abaca production and livelihoods

The majority of the workshop participants are abaca growers and thus viewed this strategy as critically important in both economic and cultural terms. The first step would be to request from government agencies and extension services, especially the Fiber Industry Development Authority (FIDA), the provision of disease-free abaca suckers for planting. Suckers measuring at least 1 m in height with a well-developed root system are used for replanting. Corms are used when the new plantation area is far from the source of planting materials. Abaca was previously grown within the forest area as the trees provided protection from typhoons. The community now plans to restore production through an agroforestry system to diversify further livelihoods and restore degraded lands. The farmers reported that abaca replanted in old plantations where tree regeneration has started and allowed to flourish was found to be less susceptible to bunchy top virus attacks in comparison with monocropping as practiced before. The incentives to implement abaca agroforestry will be enhanced by the formal recognition of land tenure as outlined in the strategy above.

To start the agroforestry plantation, people will first have to prepare the land (clearing *Imperata* grasses and other unnecessary growth) and plant the suckers and tree seedlings. Abaca can be intercropped with coconut and local fruit trees such as durian (*Durio zibethinus*), lanzones (*Lansium domesticum*), and rambutan (*Nephelium lappaceum*), and/or timber trees such as narra (*Pterocarpus indicus*), mahogany (*Swietenia macrophylla*) and acacia (*Acacia mangium*). Fruits are expensive in Southern Leyte, so a fruit-based agroforestry system might be preferable as it can provide good livelihood opportunities and also enhance food security.

Abaca can be planted with a spacing of 2.0 m x 2.0 m, 2.5 m x 2.5 m, or 3.0 m x 3.0 m, whether using suckers, seed pieces or tissue-cultured seedlings as planting materials. Farmers in Sogod prefer 2.0 m x 2.0 m. Abaca planted with a spacing of 2.5 m x 2.5 m or 3.0 m x 3.0 m is known to produce significantly higher yields than the 2.0 m x 2.0 m spacing. However, in terms of total fiber yield per hectare, abaca spaced at 2.0 m x 2.0 m gives higher fiber yield due to the greater number of plants per hectare (Gonzal and Briones 2004). Fruit trees can be planted at a 10 m x 10 m spacing (Gonzal and Briones 2004), while timber trees such as acacia can be planted at 2.0 m x 5.0 m with a thinning in the 6th year to reduce the spacing to 6.0 m x 5.0 m (Kiffner et al. 2005). Trees can be planted first and then the abaca can follow in the same year. Regular fertilizer application and weeding is needed after planting.

Both men and women engage in the land preparation, planting, and maintenance of the crops, but it is predominantly the men who do the harvesting, stripping and transporting of the fibers from the upland plots to the village. Abaca is stripped by hand or with stripping machines to obtain the fiber. Depending on the quality, fibers are classified as S1, S2, or S3. Fibers of grade S3 are sold at the lowest prices and people therefore prefer to process them into handwoven handicrafts such as sinamay, hinabol, ropes and other products. Handicrafts and other processed abaca products are predominantly made by women. Final processing and grading of abaca is done in Sogod, which is the closest buying center to the barangays. Farmers transport the fibers with buses or the local “habal-habal,” a type of motorcycle with extended seating. The buyers in Sogod then send the abaca bundles to a consolidator in Manila. Fruits are sold in village markets or in Sogod, including along the various connecting roads, or are consumed directly. Timber is sold to middlemen or used for house building and furniture making.

6.2.3 Costs and benefits

Perceptions

The community members perceived a number of different costs and benefits associated with the implementation of the two strategies (Table 6). Most of the costs relate to time input, but some involve the purchase of materials such as abaca suckers and fertilizer. The benefits indicated are enhanced income and new livelihood opportunities, resilience, and better land management. The POs are considered a major driver of socioeconomic development and sustainable resource management over the long term. People’s Organizations are also seen as an important pillar of social cohesion.

Province-level stakeholders identified some additional positive spillover effects that could occur from the two interventions, such as containment of in-migration and encroachment into forests, increased effectiveness of awareness and education campaigns (as they will be conducted through the POs) and an increase in the attractiveness and productivity of rural employment (Table 7). Labor and material inputs that will be needed from farmers were not discussed.

The costs incurred by the field offices for operationalizing CBFM strategies should be included in the CENRO, PENRO, and the Region’s Work and Financial Plans as part of the DENR’s major final output. The DENR, LGUs and other government agencies may finance development, conservation and other activities indicated in the CRMF (DENR 2004). Abaca agroforestry could be included as one such CRMF activity.

Province-level stakeholders mentioned that the costs of resource inventories, surveys and farmer census towards CBFM amount to approximately PHP 60,000 per barangay, while elaborating a FLUP at the municipal level (LGU) usually costs around PHP 180,000. With regard to implementation, the 5-year program proposed in the FLUP of Silago was estimated to cost PHP 5.5 million, including administrative costs and the implementation of the following major components: forest zoning and management, protection of conservation areas, development of community watershed and source water production, maintenance and enhancement of potential ecotourism areas, and development of municipal and barangay nurseries.

Table 6. Costs and benefits as perceived by the barangay members.

	Securing land tenure	Abaca agroforestry
Costs	• Establishing and capacitating People’s Organizations • Inventories, land-use planning, and processing of certificates (in terms of time, as most costs are borne by the local government)	• Abaca suckers or seedlings • Labor for land preparation • Maintenance labor • Fertilizers • Transport of produce • Capacity building (cost borne by extension services)
Benefits	• Better land and forest management • Security over assets • Enhanced production and livelihoods due to more security in investment • Capacitated People’s Organizations that help the communities deal with a variety of issues not only related to land and forest management, but also to disaster-risk reduction planning, etc. • Sense of community is increased as household members are encouraged to join the POs	• Increased overall economic well-being, as abaca is a sought-after commodity with strong markets • Resilient abaca production under climatic and other threats (e.g. abaca virus) • New livelihood opportunities from abaca fiber processing, especially for women • Rehabilitation of degraded land • Enhanced availability of fruits for consumption and selling

Table 7. Costs and benefits as perceived by province-level stakeholders.

	Securing land tenure	Abaca agroforestry
Costs	• Resource surveys and inventories • FLUP formulation	• Increase in land prices • Capacity building for FIDA
Benefits	• Ownership of area and tenure security • Improved household income for beneficiaries • Increased agricultural production • Proper allocation of land and sustainable management of forests and other resources • Containment or control of in-migration and encroachment into forested areas • Community organization and participation in planning processes • Enhanced results of awareness and education campaigns channeled through the POs	• Handicraft enterprise development and job opportunities for women • Enhanced or more-attractive rural employment • Increased household income

Abaca agroforestry inputs and outputs (excluding labor)
Although abaca agroforestry can be practiced without the application of fertilizers, the application of nitrogen (N), potassium (K) and a little bit of phosphorus (P) can be beneficial. Intercropping abaca with leguminous trees (e.g. acacia) is highly recommended because the trees not only provide shade, but they also enrich the soil with nitrogen through their symbiotic relationship with soil bacteria (Bande 2012). From the fruit trees, rambutan and lanzones have also been found to have higher yields if N, K, and P are applied (ICRAF 2013).

A blanket application of 14 g of N, P_2O_5, and K_2O (complete 14-14-14 fertilizer) is recommended per plant at the base during planting (Bande et al. 2013). The same rate is then recommended at 3 and 6 months after planting. The rate should be increased to 40 g per plant at 9 and 12 months. Monthly weeding and bimonthly pruning of suckers is necessary during the establishment phase.

Rambutan needs fertilizer in 4 equal dressings every 3 months for the first 4 years (ICRAF 2013). For fruiting trees, 200 g N, 25 g P and 130 g K per tree per year of age is recommended. The maximum fertilizer rate is reached at 12 years, and should remain constant thereafter. With lanzones, the application of a 6-6-6 fertilizer formula thrice yearly will result in very good growth, productivity and high-quality fruits even in adverse environments (ICRAF 2013).

According to the Bureau of Agricultural Statistics, the latest average price for a bag of complete fertilizer amounted to PHP 1254 as of January 2013. Prices have shown little fluctuation since 2012.[12]

Yields can vary according to the management practices and climate, but the general averages have been defined by the literature as illustrated in Table 8.

Intercropping abaca with established fruit trees maximizes land utilization and suppresses weed growth and pest and disease infestation (VSU n.d.). It also improves the growth and yield of both fruit trees and abaca. Shade provided by trees is especially important for protecting the young abaca plants from the sun, and the older, taller plants from wind breakage (Bande 2012). Abaca fiber yield has been shown to increase by as much as 165% under shade trees in comparison with yields in monoculture abaca plantations (Bande 2013).

6.2.4 Opportunities
Apart from the expected benefits, further opportunities could be harnessed during the implementation of the two strategies to enhance their overall positive impact. The barangay representatives mentioned that they would like to pursue additional livelihood diversification strategies once tenure over land is secured. The National Greening Program could be a source of financial inputs for the procurement of high-value fruit trees, which they could plant in their areas, as well as offering a market for seedlings of indigenous trees, which they could raise in their backyard nurseries. With the abaca agroforestry strategy, the communities reported that

12 BAS update on fertilizer prices, January 2013 http://www.bas.gov.ph/situationer/price2/FerPrSitJan2013.pdf.

Table 8. Yields and prices of the abaca agroforestry system with fruit trees.

Crop	Harvest begins at (average age)	Annual yield	Average farm gate prices	References
Abaca	1.5 years	1875 kg/ha from year 4 (full maturity), 30–40% less before full maturity (in an agroforestry system)	PHP 43/kg (average in S.Leyte 2005–2012)	Bureau of Agricultural Statistics CountrySTAT; Kiffner et al. 2005
Durian	7–8 years	8–13 yrs = 40 kg/tree 14–25 yrs = 80 kg/tree	PHP 30/kg	Rañola et al. 2007; ICRAF 2013
Rambutan	8 years	8–15 yrs = 10–42 kg/tree 16–25 yrs = 45-300 kg/tree	PHP 20/kg	Tindall 2004; Rañola et al. 2007; ICRAF 2013
Lanzones	12 years	12–15 yrs = 25 kg/tree 16–25 yrs = 45 kg/tree	PHP 30/kg	Rañola et al. 2007; ICRAF 2013

there would be opportunities to start processing the fiber directly and delivering a more finalized product, as they will be producing higher-quality raw fibers. Farmers could organize themselves into cooperatives for processing the fiber and also for producing handicrafts.

Province-level stakeholders also identified a number of opportunities associated with the two interventions. With secured land tenure, rural livelihoods would be enhanced and more sustainable, and investors could be invited to work with farmers in developing livelihoods further. Assistance from local government agencies is available for conducting FLUPs and this could be tapped into by the barangay members, especially since there are strong partnerships between the LGUs and national government agencies such as DENR in Southern Leyte. Financial and technical support from donors could also be sought and applications for credit support programs for agricultural production and social infrastructure development (e.g. cooperatives) could also be made. Financial and technical support is generally easier to obtain when land tenure is secure, and barangays/LGUs participating in CBFM have preferential access. POs will also have more access to training and seminars, which will further enhance their capacity.

With regard to abaca agroforestry, semiprocessing and other value chain activities such as weaving could be supported, as already mentioned by the communities. The implementation of this intervention is also an opportunity to make use of the extension services offered by FIDA and other agencies. FIDA has already offered abaca extension support, education and training services to farmers in the country, such as farmer field schools and skills training on making fiber-craft (e.g. handmade paper and woven fabrics), and the development of postharvest facilities such as stripping centers and drying facilities. The Department of Agriculture also offers abaca support programs, for example, the establishment of abaca solar and mechanical dryers through the Abaca Production Enhancement Program, which aims to stabilize the abaca fiber supply throughout the year and increase farmers' incomes. The high demand for abaca products abroad and the global competitiveness of the Philippines as regards fiber handicrafts are other opportunities that should not go unharnessed. The complete list of opportunities that province-level stakeholders emphasized is shown in the table below.

6.2.5 Challenges and potential unintended consequences

A number of positive opportunities could be harnessed through the two strategies, but there are challenges as well. The main challenge that the communities perceive with regard to the land tenure intervention is the enforcement of policies and regulations (e.g. encroachment from outsiders could still occur). Challenges in the monitoring of the land-use plan will arise as communities will need to know if it is implemented according to the agreements made between the multiple parties. Adequate coordination between government agencies will be needed, especially in the granting of mining permits within the areas. With the CBFM and other resource management agreements, getting assistance for badly needed infrastructure projects might become more difficult. No significant challenges or potential unintended consequences were mentioned with regard to the abaca agroforestry strategy.

Table 9. Opportunities identified by province-level stakeholders.

Securing land tenure	Abaca agroforestry
Assistance available for conducting FLUP	Support semiprocessing and other value chain activities such as weaving
Strong partnerships between LGUs and national government agencies (e.g. DENR)	Tap into assistance from agencies such as FIDA and Dep. of Agriculture
Tap financial and technical support from donors	Global competitiveness of fiber handicrafts and high demand of abaca products abroad
Apply for credit support programs for agricultural production and social infrastructure support programs	Share good practices on venturing from other livelihood sectors
Invite investors	Attract research related to abaca
Elaborate livelihood diversification programs and improve the overall sustainability of farmer livelihoods	
Training and seminars for POs	

During the province-level workshop, more challenges were mentioned. Maintaining the commitment of LGUs to implement the FLUP and the availability of technical staff to facilitate the CBFM and tenure agreement processes are just some of the challenges associated with securing land tenure. Others relate to the long approval process of CBFMAs even though, on paper, the process seems short and the longevity of government programs that are linked to it. Clarifying the activities, determining the cost of the process, and delineating the land areas correctly are challenges that will most likely be encountered at the start of the intervention.

With abaca agroforestry, the main challenges reported are the sustainable adoption of adequate intercropping practices and the timely coordination with FIDA. Identifying the underlying causes of abaca virus infestations in order to minimize future risks is another issue.

The two strategies could also result in unintended impacts that will need to be detected and dealt with as early as possible. These mostly relate to broader impacts at the provincial level. For example, speculators might take advantage of the newly established tenure agreements that could lead to farmers selling off their tenured lots. The benefit of containing migration and encroachment into forested zones might not occur and the opposite could happen. Since secure land tenure will lead to enhanced livelihoods and economic development, this could attract more new settlers from the lowlands who will need to find land for housing and agriculture. This same unintended consequence could materialize as a result of the abaca agroforestry intervention as well.

Other concerns that were flagged in relation to the abaca agroforestry intervention include “loan sharks” taking advantage of those farmers who are willing to implement the intervention on their plots, continued exploitation by middlemen along the value chain if cooperatives are not established, and conflicts with government forest protection policies if agroforestry is practiced in the forest margins or within forested lands. Adequate monitoring, capacity building and sufficient extension and financial support services could prevent such unintended consequences from occurring.

6.2.6 Viability when confronted with major climate threats

The scenarios of the future climate might be uncertain, but exactly because of this uncertainty, it is important to analyze any proposed adaptation interventions with regard to all of the main future climate threats. The particular climate conditions and thresholds where an intervention fails or stops being effective need to be singled out in order to identify any additional vulnerabilities that might occur and to elaborate plans to address them. This also helps to pinpoint early warning indicators that could be embedded in a process of adaptive management once implementation begins.

The intervention of securing land tenure does not present any risk of failure under the different plausible climate scenarios, but there are certain climate and biophysical thresholds that need to be monitored with regard to the abaca agroforestry system.

As described in chapter 5.1, the main future climate threats for Sogod are:

1. Temperature
   - Increase in annual and seasonal means (extremely likely)
   - Increase in number of days with maximum temperatures over 35°C (extremely likely)
2. Precipitation
   - Increase in annual and seasonal means, except in MAM season (likely)
   - Increase in the number of heavy precipitation days with rainfall above 300 mm (likely)
3. Extreme events
   - Increase in frequency and intensity of ENSO events (likely)
   - Increase in typhoon intensity and changes in tracks (likely)

With regard to increases in temperature, abaca grown under agroforestry systems is more resilient than monoculture plantations due to the microclimate regulation and shading provided by the trees. As mentioned above, shaded abaca results in 165% more fiber yield (Bande et al. 2013). However, drought events brought by El Niño could decrease abaca's physiological activity, especially if it occurs right after planting and before the trees have started to form their canopies (Bande 2004). Farmers should thus have the readiness to start irrigation during this initial establishment phase. In general, however, established agroforestry systems are much more resilient to drought than are monocultures. With their deep root systems, trees are able to explore larger soil depths for water and nutrients, which will confer benefit on crops in times of drought. Their contribution to increased soil porosity, reduced runoff and increased soil cover leads to increased water infiltration and retention, and reduction of moisture stress during low rainfall (Verchot et al. 2007).

Under increased precipitation, abaca agroforestry can help to prevent soil erosion because the different strata of leaves, including the large leaves of abaca, will absorb some part of the kinetic energy of raindrops (Bande 2012). Agroforestry systems as a whole are not impacted to a large degree by intense precipitation. Excess water is pumped out of the soil profile more rapidly in agroforestry plots due to their higher evapotranspiration rates (Verchot et al. 2007).

The productivity of the fruit tree species can, however, be impacted by extreme temperature and precipitation values, and measures such as irrigation and drainage canals might need to be implemented. Durian, for example, grows best with mean annual temperatures of 22°C and a mean annual rainfall of 1500–2000 mm (ICRAF 2013). Soils should be well drained to limit losses from root rot. Rambutan, on the other hand, has a higher tolerance and can thrive with annual mean temperatures as high as 35°C. This species does not favor waterlogging. Lanzones need plenty of moisture and will not tolerate long dry seasons (ICRAF 2013). The tree tolerates long rainy seasons (e.g. in Java, the tree has been shown to grow well in areas with 6–12 wet months), but not waterlogging.

However, even if fruit yield is impacted under increased temperatures or changes in precipitation, the trees will continue to provide valuable services to abaca (shade, cooling, water pumping, etc.). Abaca agroforestry systems have also been shown to recover more quickly from disturbances than do monocultures (Tabora 1991).

7. Linkages with REDD+

Adaptation and mitigation strategies generally differ in their objectives and spatial scales. Mitigation has global benefits that manifest in the longer term, whereas adaptation is primarily a local issue with more immediate benefits at that scale (Locatelli 2011). However, mitigation projects can have positive or negative impacts on the adaptive capacity of communities, and adaptation projects can either enhance or hinder mitigation goals (Locatelli et al. 2011). These linkages are particularly evident in the agriculture and forestry sectors, especially in interventions such as REDD+, and there is a growing interest in exploring how adaptation and mitigation can be pursued simultaneously to enable win–win strategies and impacts in these sectors (Locatelli 2011).

For example, REDD+ projects can contribute to the adaptation of forests to climate change by decreasing degradation pressures and forest vulnerability, maintaining biological diversity, and increasing ecosystem connectivity for enhanced resilience (Fischlin et al. 2007). They can have positive impacts (e.g. enhanced provision of ecosystem services, diversified incomes and economic activities, and strengthened local institutions) and/or negative impacts (e.g. restricted access to forest resources and dependence on external funding) on the capacity of local communities to adapt to climate change (Sunderlin et al. 2009; Caplow et al. 2011; Larson 2011).

On the other hand, adaptation projects can contribute to carbon sequestration and storage through ecosystem restoration or measures such as agroforestry. Successful adaptation to climate change in agriculture can reduce additional degradation or conversion of forests, and can thus contribute to global mitigation and to reaching REDD+ objectives (Locatelli et al. 2011). To the contrary, the lack of adaptation, or the implementation of poorly targeted interventions, can lead to more forest degradation or conversion, can increase forest vulnerability (e.g. increase risks of fire during drought), and can ultimately hinder the attainment of REDD+ targets.

Maximizing synergies and acknowledging and minimizing trade-offs between REDD+ and the adaptation of local communities will ensure that REDD+ is both contributing to national priorities and is providing benefits to poor people and vulnerable groups (Graham 2011). Taking this approach to REDD+ and adaptation can lead to the "triple wins" of climate-compatible development: keeping emissions low, building resilience to the impacts of climate change, and promoting development (Mitchell and Maxwell 2010).

With the case study in Sogod, the linkages between successful REDD+ implementation and the two community-based adaptation interventions can be explored through two scenarios. These two scenarios constitute (1) the current situation where communities employ coping strategies, and (2) the future scenario where we assume that the two adaptation interventions have met their intended outcomes. The linkages are described below based on stakeholders' perceptions and interconnections, which were recorded during the community- and province-level workshops. Several points have also been analyzed further using evidence from field studies conducted elsewhere.

7.1 Coping level

The community- and province-level workshops revealed a number of interacting challenges that all have an impact on forests and their resilience, and consequently on the accomplishment of REDD+ objectives. As mentioned in chapters 4.1, 4.2, and 5.3, insecure land tenure inhibits investments in forest and resource management, and in agricultural interventions such as agroforestry. This situation leads to a number of negative consequences (Figure 13). Due to the lack of agricultural investments, especially ones with adaptation benefits, climate stressors and disasters such as flood and drought induce decreased crop yields or even crop failure in the area. This in turn forces communities to clear more land in the uplands or to extract forest resources such as wild bats and NTFPs to supplement income and livelihoods (coping strategies).

The lack of forest management renders these resources, and the forests as a whole, more vulnerable to climate change (e.g. increases the risk of fires). Without secure tenure, communities are not incentivized to engage in sustainable forest management (SFM) and to employ proactive measures such as fire-risk reduction interventions and monitoring. The lack of agricultural investments (e.g. for more sustainable and resource-efficient practices) in combination with the various climate pressures also lead to the compound effect of land degradation, which can result in even more forest encroachment. Encroachment is aggravated by the in-migration of settlers from the lowlands, especially when there are no property rights and land-use planning in place. This in-migration is a difficult current situation for REDD+ implementation.

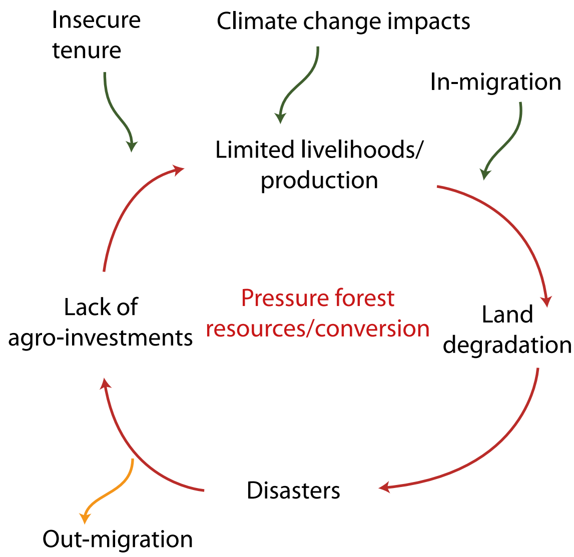

Figure 18. Coping strategies in the current situation.

As seen elsewhere in the world, it is generally the poor and most resource-insecure people who depend on forest resources after a disaster (Pramova et al. 2012). In Malawi, for example, forests appear to be important as a reactive adaptation strategy, particularly for households with no other options, but they do not currently play a role in anticipatory adaptation (Fisher et al. 2010). In Indonesia, people impacted by floods sold and consumed wild pigs from the forest to supplement livelihoods and food intake (Liswanti et al. 2011), while in Honduras, poor rural households sold timber to self-insure after being unable to recoup lost land holdings due to Hurricane Mitch (McSweeney 2005).

It is important to differentiate between products as safety nets for coping strategies (short term, usually after a disaster strikes) and products as a major source of livelihood diversification for adaptation strategies (proactive management of resources in anticipation of shocks). The poorest of the poor might turn to the forest during or after a disaster in order to survive, but some farmers also use forest and tree products as an integral income diversification strategy for dealing with climate variability on a constant basis. Many of these agrarian communities maintain trees on their farms for this purpose. When harvests are decreased due to climate events, people can sell firewood, fodder or other forest products from their farms to supplement income (Pramova et al. 2012).

With coping strategies such as the ones encountered in Honduras, but also in Southern Leyte, Philippines, a high dependence on forest products for dealing with climate events can be a source of vulnerability when the ecosystem is degraded or mismanaged, when conflicts arise between different forest users or when access becomes restricted. The future value of natural assets and how communities will be able to utilize them under REDD+ is a concern that has been raised (Peskett et al. 2008). As populations grow, and in response to other development or climate pressures, REDD+ may lead to a situation where communities are not able to rely on natural assets as much as they have previously (e.g. for cash income from logging, as safety nets in times of shock, as a source of agricultural land, etc.) (Graham 2011). Consequently, it is critical to enhance the adaptive capacities of communities and integrate adaptation strategies in REDD+ planning to foster an effective transition from coping to adapting.

This is where the GIZ-DENR Forest Policy and the REDD project intervene by promoting activities aimed at forest land use planning and as support to clear land tenure (e.g. through CBFMAs and comanagement agreements between DENR and LGUs and provision of alternatives to local communities by providing inputs through reforestation, natural forest rehabilitation and agroforestry activities). This creates the basis for more resilience and alternative livelihoods in the future (e.g. through the sale of fruit, coffee or cocoa from agroforestry systems or timber harvesting from forest plantations). In addition, the activities provide direct cash income to local households that can be invested into the education of children and building of non-forest-dependent livelihoods.

7.2 Adapting level — desired future situation

Stakeholders envision that the two adaptation strategies prioritized by the barangay members — securing land tenure and abaca agroforestry — will have a mutually enhancing and positive impact, but only if they meet their objectives and if the challenges and potential unintended consequences are managed appropriately.

With more secure land tenure and capacitated People's Organizations— a prerequisite for applying for CBFMAs and other comanagement agreements — communities will be more incentivized to invest in resource management and agricultural practices such as abaca agroforestry. Abaca agroforestry will in turn lead to enhanced livelihoods, diversified income opportunities and restoration of degraded land, all of which will contribute to reducing deforestation and to managing resources sustainably. The latter are a compound effect of secure land tenure, land-use planning, and the implementation of agroforestry (Figure 14). As a result of tenure and land-use planning, the negative effects of in-migration (e.g. encroachment into forested lands) will be constrained. Sustainable resource management of both forest and agricultural resources will lead to an overall increased social and environmental resilience. The presence of capacitated POs will further contribute to enhancing people's adaptive capacity to anticipate and deal with hazards effectively. This situation of "adapting" will facilitate the successful implementation of REDD+ and the triple objectives of adaptation, mitigation and development.

In addition to the direct impacts of adaptation projects, positive indirect impacts on REDD+ can occur when an adaptation project prevents activity displacement and induced deforestation, for example, if an agricultural adaptation intervention sustains crop productivity and livelihoods and reduces forest clearing for agricultural expansion (Locatelli 2011). The evidence on these linkages from the climate change literature is scarce, but studies have been conducted on the relationships between practices such as agroforestry and community-based forest management (relevant for adaptation) and reduced deforestation (relevant for REDD+) outside of the climate change debate.

Empirical evidence from Nepal (Gautam et al. 2002; Oli and Kanel 2006), Mexico (Bray et al. 2003) and Vietnam (Tan et al. 2009) shows that community forestry can actually lead to increases in forest cover in areas where decreases are usually the norm. If implemented through secure tenure arrangements,

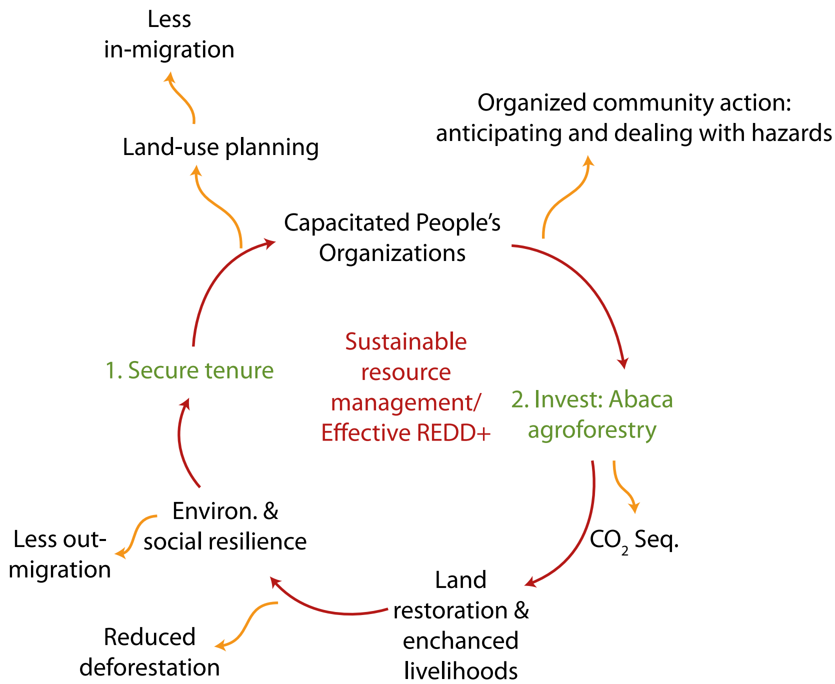

Figure 19. Future scenario of adapting.

it also has the potential to lift people out of poverty (Sunderlin et al. 2007). Another case from Sumatra, Indonesia, demonstrates how the recognition of community property rights over forests has led to a decrease of deforestation, an increase in land restoration, and the overall reduction of forest fire risks (Suyanto et al. 2005). But local communities can only become effective forest stewards when acquired rights are duly recognized, avenues exist for meaningful participation, forest management costs and benefits are distributed fairly, and appropriate external support is provided, as suggested by case studies from South America (Cronkleton et al. 2008).

The potential of agroforestry to enhance rural incomes, increase resilience to climate hazards, and restore degraded land has been well documented (Verchot et al. 2007; Garrity et al. 2010; Pramova et al. 2012). But agroforestry can also have direct and indirect effects on climate change mitigation through carbon sequestration and reduced deforestation, respectively. The Alternatives to Slash and Burn program documented the carbon sequestration and storage of different agroforestry systems (Verchot et al. 2007). Converting row crops or pastures to agroforestry systems can greatly enhance the amount of carbon stored as aboveground biomass because agroforestry systems contain 50–75 Mg C ha^{-1}, while row crops contain <10 Mg C ha^{-1}. Intercropping with fruit trees and other agroforestry systems are also found to be more profitable than short fallow monocultures and row crops, which are the typical focus of agricultural intensification programs (Gockowski et al. 2001).

Governments in many tropical countries have been promoting agricultural intensification as a replacement for simpler agroecological and swidden systems, with the aim of enhancing food production, increasing farmer income, and protecting forests from extensive clearing (Lin et al. 2008; van Vliet et al. 2012). This also contributed to a widespread belief that trees impact food crops negatively due to competition for water and nutrients. Research has shown, however, that badly planned intensification actually exacerbates vulnerability to climate change (Lin et al. 2008) and can lead to permanent deforestation with severe consequences for ecosystem services and soil fertility (van Vliet et al. 2012). The alternative approach of "agroforestry intensification" is proposed in which agricultural intensification occurs in association with trees, with the objective of conserving ecosystem services and increasing farmers' incomes (Steffan-Dewenter et al. 2007).

Agroforestry systems can have benefits for biodiversity and forest adaptation because they can serve as biological corridors and also reduce human pressure on natural forests (Schroth 2004; Bhagwat 2008). It has been demonstrated that agroforestry systems play host to significantly more species in comparison with monoculture systems (Harvey et al. 2006; Bhagwat 2008). Thus, agroforestry production, even at the forest margins, can be beneficial to both people and forests.

Studies from the Kerinci Seblat National Park in Sumatra, Indonesia, show that households owning mixed gardens containing trees extracted much fewer resources from the national park than did households cultivating rice fields alone (Murniati et al. 2001). A similar situation has been observed around the Nyungwe Forest Reserve in Rwanda (Masozera and Alavalapati 2004). Research in small islands of the Pacific has also demonstrated that the presence of valuable trees for livelihoods outside of the forests has significantly reduced deforestation and forest degradation in the reserves (Bhagwat 2008).

However, certain conditions have to be present to incentivize farmers to invest in agroforestry, illustrating once again the connections between the two adaptation strategies prioritized by the barangays in our case. Several studies have demonstrated the decisive roles that secure land tenure and decentralized decision-making processes at the community level play in agroforestry adoption rates among farmers (Suyanto et al. 2005; Swallow et al. 2006; Tougiani et al. 2009; Sendzimir et al. 2011). Those without secure tenure and property rights are less likely to participate in agroforestry initiatives because the cultivation of trees requires a multiyear investment (Garrity 2004; Pramova et al. 2012). The type of agroforestry system selected should also be responsive to local needs (e.g. needs for particular products such as fuel wood or fruits) and biodiversity (Tougiani et al. 2009; Graham and Vignola 2011).

A greater and more diverse asset base (including natural, physical, financial, human and social assets) leads to enhanced adaptive capacity at the local level (Plummer and Armitage 2010). How REDD+ is implemented will have an influence on community assets. For example, securing tenure and CBFMAs as part of REDD+ can be used as an opportunity to provide training and education to local communities on sustainable forest management, improved agricultural techniques, and monitoring, reporting and verification of REDD+ activities. Human capital will thus be built, with positive impacts on adaptive capacity (Graham 2011).

Further synergistic benefits could be pursued from a joint implementation of REDD+ and adaptation strategies in order to maximize the overall positive impact. For example, REDD+ networks and finance could be used to deliver timely climate information and knowledge that is of relevance not only for the adaptation of agrarian communities, but also for the adaptation of the forests (Graham 2011). Such information could be integrated into an adaptive governance and management model, where the results of different interventions are constantly monitored, evaluated and readjusted according to changing circumstances and needs (e.g. changing drivers of deforestation and degradation and changing climate pressures). Adaptive management should be the foundation of any intervention under uncertainty.

8. Cost–benefit analysis and SROI impacts

8.1 Cost–benefit analysis

As the monetary values for a complete SROI analysis could not be calculated due to the lack of available data, a cost–benefit analysis (CBA) was conducted, which was related to the inputs and outputs of each strategy (securing land tenure and abaca agroforestry). In the CBA analysis, the best available data were used, sourced from the literature, statistics offices, and also from stakeholder statements made during the workshops. Again, the data used for the CBA were not optimal and the results should be interpreted with caution. For this reason, the most conservative estimates were used (e.g. lowest average yield and highest average prices of inputs).

The impact maps and calculations of the two strategies of securing land tenure and implementing abaca agroforestry are merged into one, as it is assumed that communities will only invest in abaca agroforestry if land tenure agreements are in place.

Due to the lack of data, the cost–benefit analysis could only be done using the following elements:

- Cost of elaborating a FLUP (municipal level) and preparing for a CBFMA (resource inventories, surveys and farmer census) for 6 barangays (430 households) amounting to PHP 54,000 as described in chapter 6; and
- Cash flows of implementing abaca agroforestry with durian farming, where it is assumed that each household will cultivate 1 ha (total of 430 ha).

To calculate the net present value, two interest rates were used: (i) the latest fixed 3.5% rate that the Bangko Sentral ng Pilipinas will strive to maintain throughout 2013, and (ii) the historical average interest rate (1985–2013) of 10%.[13]

For the abaca agroforestry strategy, the analysis was made based on intercropping 2500 abaca plants and 100 durian trees per hectare. Other types of fruit trees could be integrated of course but the data for rambutan yields, for example, are inconclusive (see Table 8). Abaca fiber yields were estimated based on the abaca–acacia agroforestry system of Kiffner et al. (2005), with abaca in a rotation of 20 years. The fiber yield is in the range of 1031–1500 kg/ha during years 1–3, and then averages 1875 kg/year until year 21. To calculate revenues, the latest average farm gate prices of Southern Leyte (PHP 43/kg) as estimated by the Bureau of Agricultural Statistics were used.[14]

Durian yields were estimated conservatively by taking into account the latest national average per hectare (3103 kg/ha/year) and not on the best achievable yield (8000 kg/ha/year). Average yield and farm gate prices (PHP 30/kg) were sourced from the Bureau of Agricultural Statistics.[15]

All costs related to abaca (land preparation, seedlings, labor, and fertilizer) were calculated according to Kiffner et al. (2005) due to the unavailability of other suitable data that could be applied to this model. All costs were adjusted according to the 2005–2012 inflation rates in the Philippines.[16] Community stakeholders also reported that a cost of PHP 3 per 50 kg abaca fiber is usually incurred for transport to Sogod, where the produce could be sold. With regard to the costs of durian cultivation, the average costs per hectare per year of fertilizer and family and hired labor were calculated based on the latest data from the Bureau of Agricultural Statistics.[17]

Even though during the first 3 years (production years 0–2) the costs are quite high and the negative net benefit amounts to PHP –45,125,240 in total (costs of establishing the agroforestry system for 430 ha and processing FLUP and CBFM), the monetary benefits can be significant in the following years. Assuming yields materialize according to

13 http://www.tradingeconomics.com/philippines/interest-rate.

14 http://www.bas.gov.ph.

15 http://countrystat.bas.gov.ph/?cont=10&pageid=1&ma=Q70CPCOP.

16 According to the World Bank http://data.worldbank.org/indicator/FP.CPI.TOTL.ZG.

17 http://countrystat.bas.gov.ph/?cont=10&pageid=1&ma=Q70CPCOP.

the aforementioned numbers and all produce is sold, the total net benefits for 430 ha amounts to approximately PHP 6,703,582 per year until durian can be harvested, and then to an average of PHP 46,732,282 after year 8. The net present value with a discount rate of 10% amounts to 162,450,985, while with a discount rate of 3–5% it is PHP 434,959,642.

For the individual farmer (1 ha), the cash flows of the abaca agroforestry system are again negative during the first 3 years (PHP –103,687) but then amount to an average of PHP 15,590 annually until durian fruits can be harvested and sold. After year 8, the net benefit amounts to an average of PHP 108,680 per year.

However, it must be taken into account that there will be bad years when no harvest is made or not all produce is sold. Production systems could also be damaged during extreme weather events, and farm gate prices might fall drastically. Nevertheless, the implementation of the two strategies carries relatively lower risks, as securing land tenure can only result in benefits and abaca fiber can be easily marketed. The benefits related to adaptation, that is, those that are mostly associated with diversification and capacity building, are also important. There are also nonmaterial benefits such as incentives for forest resource stewardship and the establishment of agroforestry, which also have an influence on the effectiveness of REDD+.

8.2 Impact map

STAKEHOLDERS	INTENDED/UNINTENDED CHANGES	INPUTS		OUTPUTS	OUTCOME
1. Who will be affected? Who will produce the effect?	2. What will change for the stakeholders?	3. What is invested?	4. Monetary value	5. Summary of activity in numbers	6. How would you describe the change?
Farmers	Farmers have enhanced and resilient livelihoods all year round	Labor, fertilizers and transportation costs as described in chapter 8.1	As described in chapter 8.1	Abaca agroforestry with abaca planted at 2 m x 2 m spacing and fruit trees at 10 m x 10 m, resulting in 2500 abaca plants and 100 fruit trees per hectare	Diversification of income — fruits provide additional sources of income in different seasons of the year
					Improved abaca yields throughout the year due to shading and other benefits of trees
					Decreased losses of production and income when climate hazards hit
					Farmer empowerment through capacity-building programs
	Land is restored and environmental resilience is enhanced	As above	As above	As above	Reduction of soil erosion and improvement in soil productivity
					Improved water regulation services in times of drought and intense precipitation
Women	Women's livelihoods are enhanced through fiber processing activities (e.g. weaving and handicrafts)	Time (labor) and marketing	Unknown	Abaca handicrafts	Diversification of income — abaca fiber processing provides additional sources of income all year round

OUTCOME					ADJUSTING IMPACT: "WHAT ELSE CONTRIBUTED TO THE CHANGE?"			
7. Indicator: How do you measure the change?	8. Quantity: How much change?	9. Duration: How long does it last?	10. Financial proxy: What would you use to value the change?	11. Value of change ($)	Dead-weight[a]	Attribut-ion[b]	Drop-off[c]	Impact[d]
Income from fruit sales after trees reach fruiting age (year 8)	As described in chapter 8.1	Durian trees can be productive for more than 60 years, while abaca has a rotation of 20 years	Farm gate price of fruits	As described in chapter 8.1	0%	0%	Some[e]	
Income from increased yield of abaca fiber versus yields in monoculture production systems	165% increase in yield as compared with monoculture (captured in total yields of model described above)	As above	Farm gate price of abaca fiber	As described in chapter 8.1	0%	0%	0%	
Yield achieved in times of climate stress versus yields in the past or in monoculture production systems	Difficult to obtain good data (e.g. correlations between hazards and yield loss in controlled experiments)	Indefinite after establishment of system and in comparison with monocultures	Farm gate price of abaca and fruits	As described in chapter 8.1	0%	0%	Some[f]	
Increased capacity and knowledge — benefits captured above	N/A	Indefinite	Benefits captured above	N/A				
Extent of degraded land under production that would normally be left fallow	Unknown	Unknown	Cost of land restoration using other methods, market price of fertilizers	Unknown				
Decrease in irrigation needs during drought and fewer damages from flood (versus previous situation or areas where land is not restored)	Unknown	Unknown	Cost of irrigation avoided; Cost of avoided flood damages	Unknown				
Income from handicraft sales	Unknown	Unknown	Market value of handicrafts (depending on whether sold to Fair Trade organizations or not)	Unknown				

a Percentage of outcome or change that would have happened without the intervention

b Percentage of outcome or change that was induced by other stakeholders not mentioned here/outside forces

c Percentage of outcome dropping off (% of effect diminishing) in later years

d Quantity times (*) financial proxy minus (–) deadweight, attribution and drop-off

e Yields and ecosystem services drop toward the end of the productive cycle of the agroforestry system, but it is difficult to set a percentage in time.

f Yields and ecosystem services drop toward the end of the productive cycle of the agroforestry system, but it is difficult to set a percentage in time.

STAKEHOLDERS	INTENDED/UNINTENDED CHANGES	INPUTS		OUTPUTS	OUTCOME
1. Who will be affected? Who will produce the effect?	2. What will change for the stakeholders?	3. What is invested?	4. Monetary value	5. Summary of activity in numbers	6. How would you describe the change?
Barangays	Communities have enhanced adaptive and resource management capacities	Time: organizing and participating in POs, formulating FLUPs, etc.	As described in chapter 8.1	1. Capacitated People's Organizations and land tenure certificates 2. Land-use plans 3. Diversified livelihood activities	Community empowerment through POs and capacity-building programs: increase in social assets, which leads to increases in all other assets
	Barangay economies are enhanced				Communities invest in, and benefit from, different livelihood activities
	Land tenure is secured				Land-use and tenure boundaries are demarcated

OUTCOME					ADJUSTING IMPACT: "WHAT ELSE CONTRIBUTED TO THE CHANGE?"			
7. Indicator: How do you measure the change?	8. Quantity: How much change?	9. Duration: How long does it last?	10. Financial proxy: What would you use to value the change?	11. Value of change ($)	Dead-weight	Attribut-ion	Drop-off	Impact
Number of people actively participating in POs and capacity-building programs and outcomes of these programs	Unknown	Unknown	% increase in well-being (e.g. economic incomes, presence of barangay infrastructure, and barangay resource base) and % decrease of losses in economic values after climate shocks versus previous situation or barangays in Sogod where such programs are not implemented	Unknown				
Number and type of community livelihood enterprises in place and related costs and benefits	Unknown	Unknown		Unknown				
Number and type of land-use plans and their implementation or enforcement	Unknown	Unknown		Unknown				

STAKEHOLDERS	INTENDED/UNINTENDED CHANGES	INPUTS		OUTPUTS	OUTCOME
1. Who will be affected? Who will produce the effect?	2. What will change for the stakeholders?	3. What is invested?	4. Monetary value	5. Summary of activity in numbers	6. How would you describe the change?
Local government and provincial agencies	Land and resources are sustainably managed and encroachment into forests is reduced in the uplands of Sogod	Human and financial resources for: 1. Resource surveys, inventories, FLUPs and other land-use plans 2. Processing of CBFMAs and other tenure agreements 3. Capacity building for POs	1 & 2 described in chapter 8.2; 3 is unknown	As mentioned above: 1. Capacitated People's Organizations and land tenure certificates 2. Land-use plans 3. Diversified livelihood activities	Empowered communities are active forest and resource stewards Clear land-use plans limit the negative consequences of in-migration (e.g. encroachment into forests)
	Poverty and vulnerability to climate change are reduced in the uplands of Sogod				Enhanced livelihoods and capacities to anticipate and manage hazards have increased well-being and decreased vulnerability
Forest Management Bureau/DENR	Deforestation and forest degradation is reduced in the uplands of Sogod	Human and financial resources for capacity building of local and provincial government agencies and POs and formulation of land-use plans (e.g. FLUPs) and processing of CBFMAs	As above	As above	Environmental and social resilience in Sogod has led to reduced dependence on forest resources for coping. Clear land-use plans ensure no further encroachment into forests
REDD+ project proponents	Sustainability and cost-effectiveness of REDD+ implementation is enhanced	As above	As above	As above	As above

OUTCOME					ADJUSTING IMPACT: "WHAT ELSE CONTRIBUTED TO THE CHANGE?"			
7. Indicator: How do you measure the change?	8. Quantity: How much change?	9. Duration: How long does it last?	10. Financial proxy: What would you use to value the change?	11. Value of change ($)	Dead-weight	Attribut-ion	Drop-off	Impact
Percentage of deforestation and forest degradation reduction	Unknown	Unknown	Cost of forest patrolling, management and monitoring that would have been employed to protect areas at risk or environmental and social cost of deforestation — more difficult to calculate	Unknown	Depends on other programs (e.g. economic) and regulations in the area			
As above	Unknown	25 years, renewable for another 25		Unknown				
Increase in economic well-being (captured above) and reduction in impact (e.g. income and material losses) after climate hazards as compared with previous situation or other areas	Unknown	Unknown	Costs avoided of aid and post-disaster assistance when losses are big	Unknown				
Decrease in deforestation and degradation risk over the longer-term	Unknown	Unknown	Cost of forest patrolling and management and monitoring that would have been employed to protect areas at risk or environmental and social cost of deforestation — more difficult to calculate	Unknown	As above			
As above	Unknown	Unknown		Unknown				

STAKEHOLDERS	INTENDED/ UNINTENDED CHANGES	INPUTS		OUTPUTS	OUTCOME
1. Who will be affected? Who will produce the effect?	2. What will change for the stakeholders?	3. What is invested?	4. Monetary value	5. Summary of activity in numbers	6. How would you describe the change?
FIDA	Abaca production is revived and sustainable in the uplands of Sogod	Abaca seedlings and extension services	Seedlings covered above; cost of extension services unknown	Abaca agroforestry production in Sogod as described above	Achievement of organizational goals as empowered communities produce abaca through agroforestry systems (the resilience and sustainability of abaca production is enhanced)
Department of Agriculture	Agricultural production is enhanced in the uplands of Sogod	Fruit tree seedlings and extension services	Unknown	Sustainable fruit production through abaca agroforestry as described above	As above but concerning fruit
Sogod fiber processing station	The supply of quality abaca fiber is more constant throughout the year	N/A	N/A	High-quality fiber for marketing and export	Empowered communities producing abaca through agroforestry systems deliver high-quality fiber on a more constant basis as yield loss risks are minimized

OUTCOME					ADJUSTING IMPACT: "WHAT ELSE CONTRIBUTED TO THE CHANGE?"			
7. Indicator: How do you measure the change?	8. Quantity: How much change?	9. Duration: How long does it last?	10. Financial proxy: What would you use to value the change?	11. Value of change ($)	Dead-weight	Attribut-ion	Drop-off	Impact
Abaca yield in intervention areas versus previous situation or other areas and decreased incidence of yield losses to diseases and climate hazards (captured above)	165% increase in yield as compared with monoculture (captured above)	20 years rotation as described above	Costs avoided of programs targeting the re-establishment of abaca production and the reduction of disease infestation risks	Unknown				
Increase of fruit production in the uplands of Sogod (captured above)	Captured above	Depends on agroforest system productivity (e.g. fruit trees) as described above	Costs avoided of programs targeting an increase in sustainable fruit production	Unknown				
Increase in amount of fiber received from Sogod	The total abaca yield of the upland barangays, assuming that it all goes to the processing plant in Sogod	20 years rotation as described above	% increase in profits	Unknown				

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10. Annexes

10.1 Timeline of activities

Based on the above objectives, the following activities were conducted from February to September 2012 for the two sites in Indonesia and the Philippines.

Month(s) 2012	Activity
February	Desktop analysis of published information related to GIZ REDD+ sites
February	Checklist document created for site selection and sent to selected GIZ REDD+ project teams
March	Selection of sites based on communication with project teams and background information
March–April	Elaboration of detailed activity plan for workshops and discussion with partners on activities and suitable dates
April-June	Desktop study and climate modeling for the site in Indonesia
22–23 June	Community-level workshop in Indonesia
July	Synthesis of results from desktop study for district-level presentation in Indonesia
July–September	Desktop study and climate modeling for the site in the Philippines and synthesis of results for provincial-level workshop presentation
03–04 September	Community-level workshop in the Philippines
13 September	Provincial-level workshop in the Philippines
10–20 September	Semistructured interviews with district stakeholders in Indonesia and visit to Setulang

10.2 List of resources, challenges and coping mechanisms per barangay

BARANGAY	RESOURCES	CHALLENGES	COPING MECHANISMS
San Vicente	Abaca Coconut Root crops Rice fields Wildlife (fruit bats) Timberlands Households (48) People's Organization (SUPDAS)	Flood Landslide Absence of telecommunication signal Abaca virus infestation	Participated in the reforestation and agroforestation projects Asked assistance from LGUs No action on flood problem
Sta. Maria	Abaca Coconut Church School Rice fields Fish pond Carabao Agricultural lands Wildlife (hawl) Timberlands	Flood Landslide Dangerous pathway along riverbank No access road Absence of variety store Absence of health clinic Lack of potable water during droughts	Construction of footbridge for the students Transfer of dangerous pathways far from river banks

BARANGAY	RESOURCES	CHALLENGES	COPING MECHANISMS
Kahupian	Abaca Coconut Timberlands Root crops Vegetables Cut flowers Human resources (farmers, laborers, teachers, etc.) – 1800+ people Small communities (sitios) - 5	Flood Presence of earthquake fault line Absence of potable water system Low price of copra Abaca virus infestation Defective footbridge	Resorted to harvesting, selling, and processing of rattan Planted vegetables, root crops and fruit trees Participated in the REDD+ reforestation and agroforestation projects
San Juan	Forest Wildlife (fruit bats, wild pigs, tarsiers, birds, frogs, etc.) Abaca Coconut (and production of copra and charcoal)	Abaca virus infestation Flood Landslide Hunting of wildlife (wild pigs and fruit bats) Destroyed footbridge	Resorted to loans and assistance from relatives Established early warning system to inform residents of floods Asked for external support (LGUs) to repair damaged footbridge
Hipantag	Human resources (population of 361) Infrastructure (chapel and school) Natural resources (forest, wildlife, etc.) Livelihoods based on abaca and coconut	Absence of road Flood Abaca virus infestation	Utilized available transportation mode (horse and carabao) and asked for assistance from LGUs Initiated reforestation and planting of fruit trees through Alternative Learning System (ALS) Program
Benit	Abaca Coconut School Organizations (microfinance institutions and government agencies) Root crops	Landslide Absence of potable water during droughts Flood Abaca virus infestation Difficult road access to agricultural lands	Hunted wild pigs, planted root crops, and sold labor in the lowlands Asked assistance from LGU for potable water problem Organized voluntary works to improve road access
Kauswagan	Human resources (86 households) Churches: 2 Elementary school Electricity Potable water Barangay Hall Barangay Auditorium Rice fields Coconut Fish pond Small-scale mining Timberlands (800 ha) People’s Organization (KFLA) Variety store	Uphill, rough and slippery road Flood Abaca virus infestation Potential environmental problems from small-scale mining	Voluntary initiatives for improving the road conditions and also solicited assistance from LGU Planted trees (mahogany) Asked LGU to construct bridge Shifted to vegetable farming, abaca weaving, charcoal production and local labor works

10.3 List of desired future characteristics per barangay

Barangay Kahupian

A. Flooding is reduced because of the restored forest and agroforest areas.
B. Presence of diversified livelihood and agricultural production based on abaca, coconut, root crops, livestock and cut-flowers.
C. Accessible potable water system up to household level.
D. Presence of college graduates and professionals in the barangay.
E. Well-maintained farm-to-market road networks.
F. Farmers have been granted tenure of their lands.

Barangay Benit

A. Hazardous areas are evacuated and households are relocated to safer areas of the main barangay area.
B. Abaca production is restored and is sustainable.
C. Presence of more professionals (teachers, health workers, etc.).
D. Farmers are provided with tenure over their agroforest lands.
E. Water system is in place.
F. Farm-to-market road networks are well-maintained.
G. Reduced landslide and flooding because of restored forest lands.
H. Presence of bridges.

Barangay Sta. Maria

A. Presence of bridges and farm-to-market roads.
B. Landslides are controlled due to restored forest lands and presence of agroforest areas.
C. Farmers have security of land tenure.
D. Presence of strong People's Organization.
E. Installed electricity.
F. Increased number of residents because of the return of the former residents.
G. Varied agricultural production and livelihood activities.

Barangay San Juan
A. Farm-to-market road networks are in place.
B. Abaca production is restored.
C. Potable water is accessible from every household.
D. Landslide risks are reduced due to restored forest lands and developed agroforest areas.
E. Hunting of wildlife, especially fruit bats, is minimized because of the presence of livelihood and agricultural production opportunities.
F. Footbridge is strengthened.
G. New access road to potential ecotourism areas is opened.
H. Farmers have Certificates of Stewardship Contracts (CSCs).

Barangay Hipantag
A. Presence of infrastructure such as roads, bridges, barangay market, etc.
B. Absence of floods because of restored forest lands.
C. Farmers have security over their farm lots.
D. Presence of strong People's Organization.
E. More college graduates and professionals are present.
F. Strong agricultural production and livelihood activities.

Barangay Kauswagan
A. Farm-to-market road networks are present.
B. Bridges are built.
C. Abaca production is restored.
D. People's Organization is capacitated and active.
E. Farmers have been issued with Certificates of Stewardship Contracts (CSCs).
F. Well-developed agroforest and agricultural production areas are present.
G. Increased presence of wildlife such as fruit bats, wild pigs, and other species.
H. Houses are improved and well-developed.

Barangay San Vicente

A. Forest areas are restored and agroforest lands are developed.
B. Farmers have security over their lands.
C. Farm-to-market roads are in place.
D. Floods are controlled and landslides are absent because of restored and protected forest areas.
E. Women have diversified livelihood activities and household income is increased.
F. Abaca production is restored and production of coconut products is more diverse (e.g. virgin coconut oil in addition to copra).

10.4 List of community workshop participants

NAME OF PARTICIPANT	DESIGNATION/POSITION	BARANGAY
1. Cristine Logronio		Sta. Maria
2. Roberto Aupe	Representative	Sta. Maria
3. Charito B. Epis	Representative	Hipantag
4. Emalina M. Epis	Brgy. Secretary	Hipantag
5. Ruditha S. Pacaldo	Brgy. Kagawad	Hipantag
6. Manuelito P. Obor	Brgy. Kagawad	Hipantag
7. Maricel L. Dalangin	Brgy. Kagawad	San Juan
8. Camilo N. Langub	Brgy. Treasurer	San Vicente
9. Mateo A. Madelo	President, SUFDA	Concepcion
10. Benjamin A. Gullas	PO Forester	Kahupian
11. Levy P. Cenon	Brgy. Kagawad	Kauswagan
12. Andres G. Rubillos	Brgy. Kagawad	Kauswagan
13. Solidad M. Tenio	Brgy. Captain	Kauswagan
14. Henry R. Dizon	Representative	Kauswagan
15. Agapito C. Tantoy	Brgy. Kagawad	Kauswagan
16. Gemma L. Abaris	Brgy. Kagawad	Benit
17. Jocelyn C. Sanchez	Brgy. BNS	San Vicente
18. Basilisa A. Mibulos	Brgy. Captain	Kahupian
19. Cristina S. Cagurol	Brgy. Kagawad	Kahupian
20. Ma. Dolores D. Diola	Brgy. Captain	San Vicente
21. Leoniza S. Aguillon	Brgy. Kagawad	San Juan
22. Teofista A. Lara	Brgy. Kagawad	San Vicente
23. Elvira A. Ampado	Brgy. Secretary	Benit
24. Marijun H. Palate	President, KUFA	Kahupian
25. Ariston S. Bongot	Brgy. Captain	San Juan
26. William L. Abais	Brgy. Kagawad	Benit
27. Eric N. Inso	Brgy. Secretary	San Juan
28. Mario A. Abais	Brgy. Captain	Benit
29. William D. Estorpe	Brgy. Captain	Sta. Maria
30. Francisca A. Diola	Brgy. Kagawad	Sta. Maria

CIFOR Working Papers contain preliminary or advance research results on tropical forest issues that need to be published in a timely manner to inform and promote discussion. This content has been internally reviewed but has not undergone external peer review.

REDD+ interventions can help both people and forests adapt to climate change by conserving or enhancing biodiversity and forest ecosystem services. However, additional adaptation measures might be needed, such as the protection of agriculture and livelihoods and the development of fire management strategies. Such measures could support the sustainability of REDD+ interventions and the permanence of carbon stocks by preventing activity displacement and induced deforestation and by limiting or avoiding damage to the ecosystem from extreme weather events.

To design community-based adaptation interventions and assess their potential outcomes within the Southern Leyte Province REDD+ project area in the Philippines, representatives from seven upland Barangays (villages) of Sogod Municipality were involved in a bottom-up, stakeholder-focused process. A social return on investment framework was applied. Community members discussed climate and non-climate challenges and the effectiveness of their current coping strategies. Adaptation interventions were then conceived and planned, using future visioning exercises. Two interventions were prioritized: securing land tenure and developing abaca agroforestry (*Musa textilis* inter-planted with different fruit trees).

Challenges and adaptation interventions were also discussed with stakeholders from relevant local- and regional-level organizations (e.g. provincial and municipal government agencies) during a participatory workshop. Projected future climate scenarios, the sensitivity of key resources and adaptive capacity were also discussed. This resulted in a holistic understanding of the costs, benefits, opportunities and challenges associated with implementing the selected adaptation strategies not only in the target area, but also in the province more broadly.

The Southern Leyte Province REDD+ project is implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH and the Philippine Department of Environment and Natural Resources (DENR) in collaboration with local government units and local communities under the Project 'Climate-relevant Modernization of Forest Policy and Piloting of Reducing Emissions from Deforestation and Forest Degradation (REDD) in the Philippines', funded by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) under its International Climate Initiative. This study was conducted by CIFOR in collaboration with GIZ with a grant from the German Federal Ministry for Economic Cooperation and Development (BMZ).

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This research was carried out by CIFOR as part of the CGIAR Research Program on Forests, Trees and Agroforestry (CRP-FTA). This collaborative program aims to enhance the management and use of forests, agroforestry and tree genetic resources across the landscape from forests to farms. CIFOR leads CRP-FTA in partnership with Bioversity International, CIRAD, the International Center for Tropical Agriculture and the World Agroforestry Centre.

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